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INTERNATIONAL CRITICAL TABLES
OF
NUMERICAL DATA
PHYSICS, CHEMISTRY AND TECHNOLOGY

VOLUME VII

INTERNATIONAL CRITICAL TABLES OF NUMERICAL DATA, PHYSICS, CHEMISTRY AND TECHNOLOGY

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OF THE
UNITED STATES OF AMERICA

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REFRACTIVITY OF ALL GASES AND VAPORS AND OF ELEMENTARY SUBSTANCES IN THE ISOTROPIC SOLID AND LIQUID STATES

J. J. FOX AND F. G. H. TATE

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SYMBOLS

Symbols and formulae that occur in a single table are explained there.

<i>d</i>	Density.
<i>F</i>	Formula-weight in accordance with the printed formula.
<i>g</i>	As subscript, <i>g</i> indicates that the quantity pertains to the gas.
<i>H</i>	As subscript, <i>H</i> indicates that the quantity pertains to hydrogen, H_2 .
<i>M</i>	Molecular weight.
<i>n</i>	Index of refraction referred to a vacuum.
<i>p</i>	Pressure.
λ	Wave-length.
λ_μ	Value of λ when the unit is $1\mu = 10^4 \text{ \AA}$; $\lambda_\mu = 10^{-4}\lambda_\text{\AA}$.

SIMBOLE

Simbole und Formeln, die in einer einzelnen Tabelle vorkommen, sind dort erklärt.

<i>d</i>	Dichte.
<i>F</i>	Formelgewicht entsprechend der gedruckten Formel.
<i>g</i>	Als untergeschriebende Index bedeutet <i>g</i> , dass sich die Grösse auf ein Gas bezieht.
<i>H</i>	Als untergeschriebende Index bedeutet <i>H</i> , dass sich die Grösse auf Wasserstoff, H_2 bezieht.
<i>M</i>	Molekulargewicht.
<i>n</i>	Brechungsindex auf das Vakuum bezogen.
<i>p</i>	Druck.
λ	Wellenlänge.
λ_μ	Wert von λ , wenn als Einheit $1\mu = 10^4 \text{ \AA}$ gilt; $\lambda_\mu = 10^{-4}\lambda_\text{\AA}$.

SYMBOLES

Les symboles et formules qui se présentent dans une seule table sont expliqués à cette place.

<i>d</i>	Densité.
<i>F</i>	Formule-poids en accord avec la formule imprimée.
<i>g</i>	Comme souscrit, <i>g</i> indique que la quantité se rapporte à un gaz.
<i>H</i>	Comme souscrit, <i>H</i> indique que la quantité se rapporte à l'hydrogène, H_2 .
<i>M</i>	Poids moléculaire.
<i>n</i>	Indice de réfraction par rapport au vide.
<i>p</i>	Pression.
λ	Longueur d'onde.
λ_μ	Valeur de λ lorsque l'unité est $1\mu = 10^4 \text{ \AA}$; $\lambda_\mu = 10^{-4}\lambda_\text{\AA}$.

SIMBOLI

I simboli e le formule che si incontrano in ogni singola tabella sono ivi spiegate.

<i>d</i>	Densità.
<i>F</i>	Formula-peso corrispondente alla formula stampata.
<i>g</i>	Quando viene posto sotto, <i>g</i> indica che la quantità si riferisce allo stato gassoso.
<i>H</i>	Quando viene posto sotto, <i>H</i> indica che la quantità si riferisce all'idrogeno, H_2 .
<i>M</i>	Peso molecolare.
<i>n</i>	Indice di rifrazione riferito al vuoto.
<i>p</i>	Pressione.
λ	Lunghezza d'onda.
λ_μ	Valore di λ quando l'unità è $1\mu = 10^4 \text{ \AA}$; $\lambda_\mu = 10^{-4}\lambda_\text{\AA}$.

The indices for solids and liquids are given for the actual temperatures at which they were determined; those for gases and vapors have in most cases been reduced to 0°C and 760 mm of Hg by some one of several, not always concordant, formulae. As values obtained previous to 1898 have been collected by Dufet (23), such values are, in general, omitted from this section if more recent data of equal or superior accuracy are available; a discussion of them will usually be found in the recent papers.

The variation of the refractivity with temperature and pressure has been given special consideration in the case of air; for other gases and vapors the available data are included with the refractivities in Table 4, if there is an indication that the ideal gas laws do not apply.

REFRACTIVITY OF AIR

Except as the contrary is stated, the following data refer to dry air containing the normal amount (0.03%) of CO_2 . Doubling this amount of CO_2 will increase *n* by less than 1 in 10^7 (54).

TABLE 1.—REFRACTIVITY OF DRY AIR

For dispersion formulae, see Table 2; unit of $\lambda = 1 \text{ \AA}$; of $p = 1$ mm of Hg; temperature = $t, ^\circ C$

(A) Range: $\lambda = 2218$ to 8999 , $p = 760$ mm (54). Observations were made at constant *t*, and gave directly the values of *n* for pressures near 760; these were reduced to $p = 760$ on the assumption that over this short range $(n - 1)/p$ is independent of *p*. For smoothed values, see Table 3.

<i>t</i>	0°C	15°C	30°C
λ	$(n - 1)10^6$		
2218Cu			298.27
2246Cu			296.04

REFRACTIVITY: DRY AIR.—(Continued)

<i>t</i>	0°C	15°C	30°C
λ	$(n - 1)10^6$		
2303Cu			290.75
2369Cu			287.90
2392Cu	322.34	305.00	286.71
2406Cu	322.27		286.94
2441Cu	320.90	304.66	286.23
2492Cu	319.66	301.22	285.77
2618Cu	314.58	296.24	283.36
2739Fe	310.17	293.20	280.40
2766Cu	313.94	295.05	278.71
2824Cu	310.38	294.08	277.93
2851Fe	308.58		276.83
2882Cu	308.06	292.10	277.41
2918Fe	307.98	291.23	275.21
2961Cu	307.83	291.40	274.62
2987Fe	307.37	291.80	274.48
2997Cu	307.42	291.53	274.26
3010Cu	307.82	289.48	275.19
3036Cu	308.41	290.82	274.50
3055Fe		291.05	
3063Cu	306.61	290.12	275.07
3075Fe			274.73
3116Fe	304.89	288.98	274.64
3175Fe	303.43	289.40	272.02
3205Fe	303.82	288.49	272.71
3280Fe	302.89	287.25	273.25
3347Fe	302.27	285.70	272.08

REFRACTIVITY: DRY AIR.—(Continued)

t	0°C	15°C	30°C
λ	$(n - 1)10^2$		
3413Fe	302.36	285.97	271.56
3485Fe	300.45	285.70	
3513Fe	301.00	285.80	271.60
3594Fe	298.89	284.50	271.49
3640Fe	298.61	284.24	270.00
3659Fe	299.87	283.63	269.96
3701Fe	299.64	283.42	267.90
3753Fe	298.80	283.18	268.80
3787Fe		283.16	
3790Fe		282.91	
3843Fe	297.75	282.92	268.95
3846Fe			268.22
3865Fe		282.61	
3867Fe	298.14		
3906Fe	299.33	282.16	267.61
3935Fe	297.98	281.48	268.91
3969Fe		281.98	
3977Fe	296.62	281.59	268.14
3983Fe	297.37	282.14	267.73
4005Fe		281.75	
4021Fe	297.17	281.57	266.99
4076Fe	297.04	281.64	268.87
4095Fe	296.66	280.95	267.60
4118Fe	297.34	280.93	
4147Fe		280.78	266.68
4191Fe		280.77	
4210Fe	297.00	280.81	266.87
4213Fe	296.36	280.53	266.97
4233Fe		280.71	
4245Fe	296.59	280.47	266.80
4282Fe	295.61	280.76	265.07
4315Fe	296.08	280.04	266.38
4352Fe	296.75	280.59	266.28
4369Fe	295.42	279.61	266.39
4375Fe		279.83	
4422Fe	295.47	279.28	266.44
4427Fe		279.67	
4484Fe	295.09		
4494Fe		279.64	265.62
4531Fe		279.44	
4547Fe	294.73	278.90	265.50
4592Fe	294.34	279.19	265.49
4602Fe		279.07	
4647Fe	294.63	278.78	265.49
4691Fe	294.30	278.52	264.97
4736Fe	293.89	278.92	265.36
4789Fe	293.57	277.84	264.74
4859Fe	293.80	278.76	264.65
4903Fe	293.76	278.32	264.71
4966Fe	293.32	278.91	264.60
5001Fe	293.55		264.20
5012Fe		278.30	
5051Fe	293.59	276.40	264.20
5110Fe	293.05	278.43	264.33
5167Fe	292.68	277.93	263.90
5171Fe	293.09	277.69	263.73
5232Fe	293.42	277.92	263.64
5266Fe	293.87		263.65
5324Fe	293.61	277.59	263.08
5397Fe	293.01	277.19	263.61
5455Fe	292.44	277.34	263.43
5506Fe	292.26	277.28	263.60

REFRACTIVITY: DRY AIR.—(Continued)

t	0°C	15°C	30°C
λ	$(n - 1)10^6$		
5569Fe	292.59	277.90	263.13
5624Fe	293.13	277.61	263.26
5658Fe	292.37	277.07	263.00
5709Fe	293.16	277.13	262.82
5763Fe	292.51	276.75	262.41
5852Ne		276.92	262.96
5881Ne		276.81	262.99
5883Fe	292.46	276.75	
5934Fe		276.71	263.88
5944Ne		276.36	262.99
6003Fe	292.85	276.58	
6029Fe			263.41
6065Fe	291.89	276.70	262.40
6074Ne		276.42	262.61
6096Ne		276.36	262.61
6136Fe	291.52	276.60	262.34
6143Ne		276.49	262.59
6163Ne		276.21	262.66
6191Fe	291.33	276.70	262.07
6217Ne		276.15	262.57
6219Fe		276.29	
6230Fe		276.79	
6246Fe		276.73	
6252Fe	291.26	276.07	262.07
6266Ne		276.49	262.48
6297Fe	290.40	274.65	
6304Ne		275.77	262.38
6318Fe		276.74	
6334Ne		276.16	262.47
6335Fe	291.06	275.81	262.10
6382Ne		276.36	262.40
6393Fe	291.11	276.37	262.03
6400Fe		276.51	
6402Ne		276.32	262.39
6430Fe	291.04	276.14	261.53
6462Fe	290.55	276.90	262.18
6494Fe	290.70	276.18	261.80
6506Ne		276.22	262.15
6532Ne		276.10	262.27
6546Fe	290.90	276.10	261.98
6563H		276.02	
6598Ne		276.02	261.96
6609Fe	291.69	276.28	261.25
6663Fe	291.36	275.96	262.74
6678Ne		275.46	
6678Fe	290.75	276.02	261.82
6717Ne		276.02	261.81
6750Fe	290.19	276.24	262.68
6752A		275.60	
6841Fe	290.70		
6843Fe			260.94
6871A		275.09	
6916Fe			263.33
6929Ne		275.76	261.84
6937A		275.45	
6945Fe	289.97	274.93	262.13
6965A		274.87	
6978Fe	290.39	275.08	261.45
7016Fe		276.54	
7023Fe	290.91		
7030A		274.90	
7032Ne		275.71	261.74

REFRACTIVITY: DRY AIR.—(Continued)

t	0°C	15°C	30°C
λ	$(n-1)10^6$		
7038Fe			261.01
7059Ne		273.70	
7067A		274.87	
7068Fe	290.24	276.71	262.41
7090Fe	290.53		
7130Fe	289.87	275.76	260.90
7147A		274.99	
7164Fe	289.50	276.12	261.36
7173Ne		275.67	
7187Fe		274.93	262.64
7207Fe		275.29	
7223Fe	290.57		260.89
7245Ne		275.26	261.66
7272A		274.88	
7293Fe	291.45		262.24
7372A		275.12	
7383A		274.66	
7389Fe	289.77		261.18
7411Fe	290.06	275.19	262.02
7438Ne		274.24	
7445Fe	290.36	275.62	260.94
7495Fe	290.68	276.45	261.27
7503A		274.83	
7511Fe		274.97	
7514A		274.89	
7531Fe	289.72	274.07	261.66
7568Fe			260.68
7586Fe	290.30		261.66
7620Fe		274.81	259.47
7635A		274.61	
7664Fe	289.58	274.81	261.12
7710Fe			261.12
7724A		274.49	
7748Fe	289.02	274.17	260.31
7780Fe	289.74	274.73	260.29
7832Fe	290.23	275.06	261.12
7937Fe	288.78	274.55	261.54
7945Fe	290.49	274.71	261.27
7948A		274.54	
7998Fe	288.67	274.87	260.66
8006A		274.58	
8014A		274.36	
8046Fe	289.03	275.01	260.56
8085Fe	290.26	273.92	261.00
8103A		274.28	
8115A		274.20	
8220Fe	289.52	273.61	261.22
8264A		274.25	
8327Fe	289.43	273.88	260.66
8387Fe	289.04	274.12	259.93
8408A		274.36	
8424A		274.27	
8468Fe	290.01		260.66
8514Fe		274.59	260.42
8521A		274.63	
8611Fe			259.90
8661Fe	288.10	274.07	260.10
8674Fe			261.26
8688Fe	288.73	273.41	260.48
8824Fe		273.55	260.54
8999Fe		273.56	259.15

(B) Values by various observers. Range: $\lambda = 2\ 652$ to $130\ 000$. For older values, see (23, 54, 58). Data reduced by the formula

$$r_0 = r \cdot \frac{760}{p} \cdot \frac{1 + \alpha t}{1 + \gamma p}; \quad r = (n-1)10^6$$

λ	r_0	λ	r_0	λ	r_0
$\gamma = 0, \alpha = \frac{1}{2}73$ (29)		$\gamma = 7(10)^{-7}$, $\alpha = 0.003670$ (35)		(81)	
2 652	314.00	5 894	292.98	5 461	291.41
2 894	309.02	67 094	288.06	(25)	
2 967	307.37	86 784	288.75	4 359	295.2
3 022	306.62			5 461	292.9
3 188	304.30				
3 965	298.00	$\gamma = 7(10)^{-7}$, $\alpha = 0.003670$ (75)*		(84)	
4 471	295.55	10 000	290	8 000	290.9
4 713	294.40	20 000	289	10 000	289.7
5 016	293.50	30 000	289	20 000	288.2
5 876	291.96	40 000	289	30 000	288.5
6 678	291.20			40 000	288.0
$\gamma = 0, \alpha = \frac{1}{2}73$ (14)		* Based on preceding value for $\lambda = 5894$, Koch (35)		50 000	287.9
4 861	295.11			63 000	287.3
5 461	293.60			80 000	287.8
5 790	292.98	(62)		130 000	286.9
6 563	291.92	5 461	293.42		

Variation of Refractivity of Air with Temperature, Pressure and Humidity

Temperature.— $(n-1)_0 = (n-1)_t \cdot (1 + \alpha t)$. Meggers and Peters (54) find $\alpha = 0.00367 + \frac{0.000003}{\lambda_\mu^2}$; Koch (35) and Statescu

(75) used $\alpha = 0.003670$; Pèrard (59) used $\alpha = 0.003716$; Cuthbertson (14), Howell (29), and most of the other workers have used $\alpha = 0.003663 = \frac{1}{2}73$. At $t = -189$ to -188°C , Ayres (3) obtained the following values, agreeing with those of Scheel (68):

λ		507	735	914 mm of Hg
5461 Å	$(n-1)10^6 =$	654.3	954.1	1189.9
5780 Å	$(n-1)10^6 =$	653.3	951.1	1186.4

Pressure.—For small ranges in p , t constant, $(n-1)/p$ may be regarded as a constant. Opinions differ regarding the effect of relatively great changes. Mathews (53) concludes that $(n-1)/p$ is constant over the range $p = 26$ to $p = 760$ mm, but many consider that Mascart's relation, $(n-1)/p = K(1 + \gamma p)$, fits the observations better; the following values have been used for γ , the unit of p being 1 mm of Hg:

λ	5 461	5 461	5 462
p	0 to 760	0 to 760	760 to 7 600
$10^8\gamma$	357 ± 39	667 ± 87	51 ± 5
Lit.....	(62)	(81)	(58)
λ	4 359	4 000 to 6 500	5 000 to 86 000
p	760 to 7 600	near 760	0 to 760
$10^8\gamma$	53 ± 5	240	70
Lit.....	(58)	(59)	(35)

For the range $\lambda = 4050$ to 5090 Å, $p = 30$ to 100 atm., $t = 9$ to 14°C , it has been found (70, 71, 73) that, whatever the pressure,

$$\frac{(n-1)\lambda}{(n-1)_{5461}} = 0.98086 \left\{ 1 + \frac{0.0056376}{\lambda_\mu^2} + \frac{54.01(10)^{-6}}{\lambda_\mu^4} \right\}$$

For variation with p at $t = -188^\circ\text{C}$, see preceding text.

Humidity.—If n_d and n_m = index for dry air and for air in which the partial pressure of water vapor is m mm of Hg, then

$$\text{Lorenz (43) concludes that } n_d = n_m + \frac{41m(10)^{-6}}{760}$$

TABLE 2.—DISPERSION FORMULAE FOR DRY AIR

$$\lambda_{\mu} = 10^{-4}\lambda_A, \text{ unit of } \lambda_A = 1 \text{ \AA}$$

For the formula $(n-1)10^6 = \beta/(\mu - \lambda_{\mu}^{-2})$, Cuthbertson (14) finds $\beta = 51\,626$, $\mu = 179.17$; for the Cauchy formula $(n-1)10^6 = A + B\lambda_{\mu}^{-2} + C\lambda_{\mu}^{-4}$, the following values have been found, those of (54) being the best. Temperature is t , °C; pressure = 760 mm of Hg, except as noted.

t , °C	A	B	C	$1000B/A$	$10^6C/A$	Lit.
0	287.566	1.3412	0.03777	4.6641	131.35	(54)
15	272.643	1.2288	0.03555	4.5076	130.39	(54)
30	258.972	1.2259	0.02576	4.7337	99.47	(54)
0	287.987*	1.804*	0	6.264*	0	(65)
0	288.02	1.482	0.0309	5.145	107.3	(59)
11				5.638†	54.01†	(70, 71, 73)

* Freed of CO₂.

† For pressures between 30 and 100 atm., $t = 12^\circ\text{C}$, $4050 \text{ \AA} < \lambda < 5090 \text{ \AA}$.

TABLE 3.—CORRECTIONS FOR CONVERTING WAVE-LENGTHS AND THEIR RECIPROCAL IN AIR AT 15°C AND 760 MM OF Hg TO THEIR VALUES IN A VACUUM (54)

If λ_a , λ_v = values in air and in vacuum, respectively, then $\lambda_v = \lambda_a + \delta_\lambda$ and $1/\lambda_a = 1/\lambda_v + \delta_\nu$, where δ_λ and δ_ν have the values given in the table. The values of $(n-1)$ are those computed by means of the equation $(n-1)10^6 = 272.643 + 1.2288\lambda_{\mu}^{-2} + 0.03555\lambda_{\mu}^{-4}$ which was derived from the observations in Table 1, section A. Unit of λ and $\delta_\lambda = 1 \text{ \AA}$; of $\delta_\nu = 1 \text{ cm}^{-1} = 10^8 \text{ \AA}^{-1}$.

λ	$(n-1)10^6$	δ_λ	δ_ν
2 000	325.582	0.6512	16.274
2 050	322.012	0.6601	15.703
2 100	318.786	0.6695	15.175
2 150	315.863	0.6791	14.687
2 200	313.207	0.6891	14.232
2 250	310.787	0.6993	13.808
2 300	308.575	0.7097	13.412
2 350	306.550	0.7204	13.041
2 400	304.691	0.7313	12.692
2 450	302.981	0.7423	12.363
2 500	301.405	0.7535	12.053
2 550	299.948	0.7649	11.759
2 600	298.600	0.7764	11.481
2 650	297.350	0.7880	11.217
2 700	296.188	0.7997	10.967
2 750	295.108	0.8115	10.728
2 800	294.100	0.8235	10.500
2 850	293.160	0.8355	10.283
2 900	292.280	0.8476	10.076
2 950	291.457	0.8598	9.877
3 000	290.685	0.8721	9.687
3 050	289.960	0.8844	9.504
3 100	289.279	0.8968	9.329
3 150	288.638	0.9092	9.160
3 200	288.033	0.9217	8.998
3 250	287.463	0.9343	8.842
3 300	286.924	0.9469	8.692
3 350	286.415	0.9595	8.547
3 400	285.933	0.9722	8.407
3 450	285.476	0.9849	8.272
3 500	285.043	0.9977	8.142
3 550	284.632	1.0104	8.016
3 600	284.241	1.0233	7.893
3 650	283.869	1.0361	7.774
3 700	283.516	1.0490	7.660

TABLE 3.—(Continued)

λ	$(n-1)10^6$	δ_λ	δ_ν
3 750	283.179	1.0619	7.550
3 800	282.858	1.0749	7.442
3 850	282.551	1.0878	7.337
3 900	282.259	1.1008	7.235
3 950	281.979	1.1138	7.137
4 000	281.712	1.1268	7.041
4 050	281.456	1.1399	6.948
4 100	281.211	1.1530	6.857
4 150	280.976	1.1661	6.769
4 200	280.751	1.1792	6.683
4 250	280.536	1.1923	6.599
4 300	280.329	1.2054	6.517
4 350	280.130	1.2186	6.437
4 400	279.939	1.2317	6.360
4 450	279.755	1.2449	6.285
4 500	279.578	1.2581	6.211
4 550	279.408	1.2713	6.139
4 600	279.244	1.2845	6.069
4 650	279.086	1.2978	6.000
4 700	278.934	1.3110	5.933
4 750	278.788	1.3242	5.868
4 800	278.646	1.3375	5.804
4 850	278.509	1.3508	5.741
4 900	278.378	1.3640	5.680
4 950	278.250	1.3773	5.620
5 000	278.127	1.3906	5.561
5 050	278.008	1.4039	5.503
5 100	277.893	1.4173	5.447
5 150	277.781	1.4306	5.392
5 200	277.674	1.4439	5.336
5 250	277.569	1.4572	5.285
5 300	277.468	1.4706	5.234
5 350	277.370	1.4839	5.183
5 400	277.275	1.4973	5.133
5 450	277.183	1.5106	5.084
5 500	277.094	1.5240	5.037
5 550	277.007	1.5374	4.990
5 600	276.923	1.5508	4.944
5 650	276.841	1.5642	4.899
5 700	276.762	1.5775	4.854
5 750	276.685	1.5909	4.811
5 800	276.610	1.6043	4.768
5 850	276.537	1.6177	4.726
5 900	276.466	1.6311	4.685
5 950	276.398	1.6446	4.644
6 000	276.331	1.6580	4.604
6 050	276.265	1.6714	4.565
6 100	276.202	1.6848	4.527
6 150	276.140	1.6983	4.489
6 200	276.080	1.7117	4.452
6 250	276.022	1.7251	4.415
6 300	275.965	1.7386	4.379
6 350	275.909	1.7520	4.344
6 400	275.855	1.7655	4.309
6 450	275.802	1.7789	4.275
6 500	275.751	1.7924	4.241
6 550	275.700	1.8058	4.208
6 600	275.651	1.8193	4.175
6 650	275.604	1.8328	4.143
6 700	275.557	1.8462	4.112
6 750	275.511	1.8597	4.081
6 800	275.467	1.8732	4.050
6 850	275.423	1.8866	4.020
6 900	275.381	1.9001	3.990

TABLE 3.—(Continued)

λ	$(n-1)10^6$	δ_λ	δ_p
6 950	275.339	1.9136	3.961
7 000	275.299	1.9271	3.932
7 050	275.259	1.9406	3.903
7 100	275.221	1.9541	3.875
7 150	275.183	1.9676	3.847
7 200	275.146	1.9811	3.820
7 250	275.110	1.9945	3.793
7 300	275.074	2.0080	3.767
7 350	275.039	2.0215	3.741
7 400	275.006	2.0350	3.715
7 450	274.972	2.0485	3.690
7 500	274.940	2.0620	3.665
7 550	274.908	2.0756	3.640
7 600	274.877	2.0891	3.616
7 650	274.846	2.1026	3.592
7 700	274.817	2.1161	3.568
7 750	274.788	2.1296	3.545
7 800	274.759	2.1431	3.522
7 850	274.731	2.1566	3.499
7 900	274.703	2.1702	3.476
7 950	274.676	2.1837	3.454
8 000	274.650	2.1972	3.432
8 050	274.624	2.2107	3.410
8 100	274.599	2.2243	3.389
8 150	274.574	2.2378	3.368
8 200	274.549	2.2513	3.347
8 250	274.525	2.2648	3.326
8 300	274.502	2.2784	3.306
8 350	274.478	2.2919	3.286
8 400	274.456	2.3054	3.266
8 450	274.434	2.3190	3.246
8 500	274.412	2.3325	3.227
8 550	274.390	2.3460	3.208
8 600	274.369	2.3596	3.189
8 650	274.349	2.3731	3.170
8 700	274.328	2.3867	3.152
8 750	274.309	2.4002	3.134
8 800	274.289	2.4137	3.116
8 850	274.270	2.4273	3.099
8 900	274.251	2.4408	3.080
8 950	274.232	2.4544	3.063
9 000	274.214	2.4679	3.046
9 050	274.196	2.4815	3.029
9 100	274.179	2.4950	3.012
9 150	274.161	2.5086	2.995
9 200	274.144	2.5221	2.979
9 250	274.128	2.5357	2.963
9 300	274.111	2.5492	2.947
9 350	274.095	2.5628	2.931
9 400	274.079	2.5763	2.915
9 450	274.064	2.5899	2.899
9 500	274.048	2.6035	2.884
9 550	274.033	2.6170	2.869
9 600	274.018	2.6306	2.854
9 650	274.004	2.6441	2.839
9 700	273.989	2.6577	2.824
9 750	273.975	2.6713	2.809
9 800	273.961	2.6848	2.795
9 850	273.947	2.6984	2.780
9 900	273.934	2.7119	2.766
9 950	273.920	2.7255	2.752
10 000	273.907	2.7391	2.738

TABLE 4.—REFRACTIVITY OF GASES AND VAPORS

For dispersion formulae, see Table 5

Order: Elementary substances, pure compounds, mixtures. The formula used for reducing the observations is indicated, if known, by *I*, *II*, or *III*: *I*, $r_0 = r \cdot \frac{760(1 + \alpha t)}{p(1 + \gamma p)}$, unless other values are given, $\gamma = 0$ and $\alpha = \frac{1}{2}73$; *II*, $r_0 = rd_0/d$; *III*, $r_0 = r[(F/d)_{0,t,p} \times [(d/M)_H]_{0,760}]$; $r = (n-1)10^6$. If the gas is ideal and diatomic, and if $\gamma = 0$ and $\alpha = \frac{1}{2}73 (= 0.003663)$, all three formulae give the same value, and $r_0 = 10^6(n-1)_{0,760}$. $K \equiv r_0/p$. Unit of $\lambda = 1 \text{ \AA}$; of $p = 1 \text{ mm of Hg}$; temperature = $t, ^\circ\text{C}$.

I. A-Table.—Elementary Substances

A, Argon; cf. (82)*		Br ₂ —(Continued)	
λ	r_0	λ	r_0
<i>I</i> (65)			
2 441.6	303.78	6 438	1 157.0
2 492.1	302.80	6 708	1 152.5
2 618.4	300.38	<hr/>	
2 766.4	298.11	Cd ₂ , Cadmium	
2 824.4	297.14	<i>III</i> (20)	
2 961.2	295.50	5 183	2 780
3 349.3	291.62	5 461	2 725
4 275.1	286.34	5 893	2 675
4 651.1	284.99	6 562	2 675
5 105.6	283.79	<hr/>	
5 153.2	283.67	Cl ₂ , Chlorine	
5 218.2	283.50	<i>III</i> (18)	
5 700.2	282.55	4 799.9	791.66
5 782.2	282.47	5 085.8	787.91
<i>III</i> (16); cf. (12)		5 209.1	786.51
4 800	283.8	5 460.7	784.00
5 086	283.1	5 769.5	781.35
5 209	282.8	5 790.5	781.21
5 461	282.3	6 438.5	777.03
5 769	281.7	6 707.85	775.63
5 790	281.7	<hr/>	
6 438	280.9	F ₂ , Fluorine	
(7)		<i>III</i> (21)	
4 861	286.0	5 893	195 ca.
5 016	285.6	<hr/>	
5 461	284.6	H ₂ , Hydrogen*	
5 876	283.8	<i>I</i> (14)	
5 896	283.7	4 861	140.64
6 563	282.9	5 461	139.71
(1)†		5 780	139.33
4 359	285.1	6 563	138.66
5 461	281.6	<i>I</i> (35, 36); cf. (34)	
5 770	280.2	2 303	159.435
5 790	280.2	2 379	157.693
6 439	279.6	2 448	156.300
* At 0°C and 760 mm Hg, (82)		2 465	155.978
finds $r_0 = 282.70$ for $\lambda = 5462.3$.		2 536	154.694
† Less accurate than those of (16).		2 577	154.017
As ₂ , Arsenic		2 676	152.538
<i>III</i> (20)		2 754	151.510
5 461	1 579	2 761	151.423
5 893	1 552	2 858	150.268
<hr/>		2 894	149.873
Br ₂ , Bromine		2 926	149.530
<i>III</i> (18)		2 968	149.118
5 461	1 184.9	3 127	147.717
5 600	1 179.6	3 133	147.661
5 700	1 176.2	3 342	146.130
5 750	1 174.1	3 545	144.950
5 800	1 173.5	3 664	144.321
6 000	1 166.2	3 705	144.103
		3 908	143.246
		3 985	142.979

H₂—(Continued)

λ	r_0
4 048	142.749
4 079	142.642
4 109	142.550
4 360	141.785
4 917	140.527
5 462	139.660
5 895	139.24
6 710	138.53
67 094	136.10
86 784	136.06

(43)

5 896	138.7
6 708	138.0

I (48) $\gamma = 0, \alpha = 0.00381$

5 085	130.2
5 896	138.7
6 438	138.3

(60)

4 677	140.8
4 800	140.6
5 085	140.0
5 378	139.3
5 896	139.0
6 438	138.5

I (68)

4 358	140.6
4 712	139.8
4 922	139.6
5 780	138.9
6 676	137.6

I (29)

2 753	151.87
2 894	150.61
3 022	149.73
3 341	147.37
4 026	144.40
4 471	142.80
4 713	142.38
4 916	142.03
5 876	141.05

I (33)

1 854.6	175.996
1 862.7	175.541
1 935.8	171.824
1 990.5	169.395
2 303	159.418
2 379	157.681
2 536	154.690
2 754	151.500
2 894	149.859
2 968	149.101
3 342	146.133
4 048	142.741
4 079	142.632
4 360	141.773
5 461	139.650†

* For the range $56 < p < 2760$ mm of Hg and $t = \text{constant}$, $(n - 1)10^6 = kp$, even at very low temperatures; for $\lambda = 5461$, $k = 0.615$ if $t = -187.5^\circ\text{C}$, and $k = 0.687$ if $t = -191.1^\circ\text{C}$; for $\lambda = 5780$, $t = -191.1^\circ\text{C}$, $k = 0.683$ per mm of Hg (3).

† Same value found by Schacherl (67).

He, Helium; cf. (82)

λ	r_0
<i>III</i> (16)	
4 800	35.04
5 086	34.99
5 209	34.98
5 461	34.95
5 769	34.82
5 791	34.92
6 438	34.86

I (37)

2 303	36.258
2 379	36.146
2 448	36.063
2 465	36.046
2 536	35.959
2 577	35.916
2 676	35.827
2 754	35.760
2 761	35.749
2 858	35.672
2 894	35.646
2 926	35.624
2 968	35.605
3 342	35.396
3 545	35.133
3 861	35.197
3 985	35.173
4 109	35.139
4 917	34.989
5 462	34.925

I (7)

4 861	35.10
5 016	35.08
5 461	35.04
5 876	35.00
5 896	35.00
6 563	34.95

Hg₂, Mercury*III* (20)

5 183	1 885
5 461	1 882
5 893	1 866
6 562	1 799

I₂, Iodine**III* (18)

5 000	2 120
5 005	2 160
5 100	2 210
5 250	2 250
5 600	2 170
6 180	2 130
6 215	2 130
6 438	2 100
6 708	1 970

* Not very accurate.

K, Potassium*

* For dispersion near absorption bands, see Bevan (5).

Kr, Krypton*III* (16)

4 799.9	431.80
5 085.8	430.34
5 029.1	429.78
5 460.7	428.74
5 769.5	427.64

Kr.—(Continued)

λ	r_0
5 790.5	427.61
6 438.5	425.80
6 707.8	425.33

N₂, Nitrogen;* cf. (83)*I* (14)

4 861	301.21
5 461	299.77
6 563	298.16

I (37) $\alpha = 0.003675$

2 379	326.09
2 448	324.11
2 465	323.64
2 536	321.80
2 577	320.84
2 676	318.71
2 754	317.21
2 760	317.08
2 858	315.42
2 894	314.84
2 926	314.34
2 968	313.74
3 342	309.37
3 545	307.64
3 705	306.36
3 908	305.11
3 985	304.73
4 079	304.24
4 109	304.06
4 917	301.06
5 461	299.77

I (68) $\alpha = 0.003675$

4 358	302.0
4 712	301.4
4 922	299.9
5 461	298.2
5 780	297.6
6 576	296.1
7 056	294.5

I (66)

3 342	307.0
3 650	303.4
4 046	301.0
4 358	299.5
5 461	296.7
5 769	296.6

(3)

 $t = -189.2^\circ\text{C}; \lambda = 5461 \text{ \AA}$ $\Delta \dagger = 0.036p$

$p \dagger$	$(n - 1)10^6$
10.1 cm	133.3
21.9	288.2
35.5	461.8
42.8	558.9
76.2	1 004.0
76.4	1 009.9
76.6	1 008.6
100.9	1 347.0
101.0	1 349.3
122.8	1 662.5
122.8	1 659.0
143.4	1 961.1
143.5	1 962.9
149.5	2 049.7

N₂—(Continued) $t = -190.6^\circ\text{C}; \lambda = 5461 \text{ \AA}$ $\Delta \dagger = 0.035p$

$p \dagger$	$(n - 1)10^6$
10.8 cm	144.1
22.2	294.4
35.6	470.6
39.0	515.3
72.6	975.4
76.3	1 023.3
110.4	1 508.3
123.3	1 692.4
132.3	1 829.9

 $t = -191.6^\circ\text{C}; \lambda = 5461 \text{ \AA}$ $\Delta \dagger = 0.23p$

$p \dagger$	$(n - 1)10^6$
11.0 cm	149.8
20.2	278.5
33.9	456.6
75.8	1 034.3
119.6	1 669.5

* At 21°C , $\lambda = 5461 \text{ \AA}$, and d between $70d_0$ and $200d_0$, $d_0 = \text{density at } 0^\circ\text{C and } 760 \text{ mm}$, $\frac{n^2 - 1}{n^2 + 2} \cdot \frac{d_0}{d} (= 199.7 \times 10^{-6})$ is more nearly constant than either $(n^2 - 1)/d$ or $(n - 1)/d$ (57).

† If computed by van der Waals's equation with $a = 126\,070$, $b = 1.325$, then both $(n - 1)/d$ and $(n^2 - 1)/(n^2 + 2)d$ are constant within 2%.

‡ $\Delta = (n_{5461} - n_{5780}) \times 10^6$, where 5780 is the mean λ of the yellow lines of Hg; p is expressed in cm of Hg. At -191.6°C the coefficient of p is nearly 7 times as great at -190.6°C .

Na, Sodium*

* For dispersion near absorption bands, see Bevan (5).

Ne, Neon*III* (16)

4 799.9	67.31
5 085.8	67.23
5 209.1	67.21
5 460.7	67.16
5 769.5	67.10
5 790.5	67.10
6 438.5	67.02

O₂, Oxygen**I* (14)

4 861	273.45
5 461	271.70
5 790	270.99
6 563	269.75

I (29)

2 753	324.23
2 894	293.60
3 022	291.19
3 188	287.93
3 889	279.65
4 471	276.31
4 713	275.11
5 016	274.01
5 876	271.84
6 678	270.83

O₂.—(Continued)		O₃.—(Continued)		HI, Hydriodic acid		N₂O.—(Continued)	
λ	r_0	λ	r_0	λ	r_0	λ	r_0
(1)				III (18)			
4 359	274.7	6 438	509.68	4 799.9	939.00	5 790.5	508.48
5 461	270.6	6 708	507.64	5 085.8	932.57	6 438.5	506.16
5 780	270.1	P₂, Phosphorus		5 209.1	930.15	6 707.8	505.44
6 439	269.2	III (10)		5 460.7	925.80	(50)*; cf. (83)	
I (66)		5 893	1 197	5 769.5	921.06	4 800.2	523.0
3 342	283.2	Rb, Rubidium*		5 790.5	920.87	5 086.1	520.7
4 047	277.6	* For dispersion near absorption bands, see Bevan (5).		6 438.5	913.34	5 378.9	519.2
4 359	275.2	S₂, Sulfur		6 707.8	910.87	6 439.2	513.2
5 461	272.5	III (10)		SO₂, Sulfur dioxide		* Gas not pure.	
5 771	271.9	5 893	1 101	III (15)		NH₃, III* (18)	
I (35); cf. (34)		Se₂, Selenium		5 000	668.63	4 799.9	383.00
$\gamma = 11(10)^{-7}$; $\alpha = 0.003674$		III (20)		5 461	663.97	5 085.8	380.83
4 359.6	274.30	5 461	1 570	5 800	661.26	5 209.1	380.02
5 462.3	270.44	5 540	1 560	6 500	657.10	5 460.7	378.60
5 893	269.68	5 893	1 565	6 700	656.40	5 769.5	377.07
6 709.7	268.31	6 540	1 530	I (77)		5 790.5	377.01
67 094	264.30	6 562	1 535	4 359	696.3	6 438.5	374.55
86 784	265.03	Te₂, Tellurium		5 461	682.0	6 707.8	373.76
III (18)		III (20)		6 708	660.6	I† (47)	
4 800	273.66	5 461	2 620	III* (31)		$\alpha = 0.00390$	
5 085	272.72	5 893	2 495	5 350	665.5	4 358	396.1
5 209	272.37	6 562	2 370	5 889	661.0	4 861	391.8
5 461	271.70	Xe, Xenon		6 707	656.7	5 461	387.0
5 770	271.02	III (16)		(79)		5 875	384.8
5 790	270.98	4 799.9	712.8	5 893	676	6 563	382.6
6 438	269.88	5 085.8	709.2	* Reduced to this basis by Cuthbertson (15).		* Data given with reserve.	
6 708	269.52	5 209.1	707.9	SO₃, Sulfur trioxide		† Reduced to 0°C and 760 mm by using $\alpha = 0.003914$, then reduced this value to what it would be if $(n-1)/p$ were constant and p had such a value that the number of formula-weights per unit volume was equal to the number of moles of H ₂ per unit volume at 0°C and 760 mm. These would agree with the following data (47) if reduced in the same way.	
* At -189.9°C, $\lambda = 5461 \text{ \AA}$, and $54 < p < 372 \text{ mm of Hg}$, $(n-1)10^6 = 1.185p$ (3). At 20°C, $\lambda = 5461 \text{ \AA}$, and d between 50 d_0 and 200 d_0 , $d_0 = \text{density at } 0^\circ\text{C and } 760 \text{ mm}$, $(n^2-1)d_0/(n^2+2)d (= 181.4 \times 10^{-6})$ is more nearly constant than either $(n^2-1)/d$ or $(n-1)/d$ (57).		5 460.7	705.5	III (19)		PH₃ (24)	
O₃, Ozone		5 769.5	702.9	5 893	737	White	789
III (18)		5 790.5	702.8	H₂S, Hydrogen sulfide		PCl₃ (51)	
4 800	532.90	6 438.5	698.7	III (15)		5 893	1 740
5 085	526.21	6 707.8	697.3	4 861	650.98	CO; cf. (83)	
5 209	523.75	Zn₂, Zinc		5 461	644.03	I (11)	
5 461	520.00	III (20)		5 790	641.17	4 800	339.20
5 770	516.24	5 183	2 070	6 563	636.22	5 085	337.82
5 790	515.14	5 461	2 150	SF₆, I (63)		5 209	337.32
II. B-Table.—Chemical Compounds, Standard Arrangement; v. Vol. III, p. viii		5 630	2 020	5 893	783	5 461	336.40
H₂O, Water		5 893	2 050	SeF₆, I (63)		5 770	335.42
λ	r_0	5 893	2 065	5 893	895	5 790	335.35
III (18)		6 562	1 960	TeF₆, I (63)		6 438	333.79
4 799.9	254.95	HCl.—(Continued)		5 893	991	6 708	333.27
5 085.8	253.80	λ	r_0	NO, III (18)		(28)	
5 209.1	253.45	5 460.7	448.00	4 799.9	297.76	4 472	340.8
5 460.7	252.70	5 769.5	446.66	5 085.8	296.66	4 713	339.4
5 769.5	251.95	5 790.5	446.56	5 209.1	296.22	4 922	338.3
5 790.5	251.91	6 438.5	444.44	5 460.7	295.50	5 016	337.9
6 438.5	250.69	6 707.8	443.75	5 769.5	294.74	5 790	335.35
6 707.8	250.28	HBr, Hydrobromic acid		5 790.5	294.68	6 438	333.79
HCl, Hydrochloric acid		III (18)		6 438.5	293.44	6 708	333.27
III (18)		4 799.9	621.60	6 707.8	293.06	I (35, 38)	
4 799.9	451.87	5 085.8	618.24	NO₂, I (17)		$\alpha = 0.003667$	
5 085.8	450.07	5 209.1	617.04	6 438	508.7	2 379	386.7
5 209.1	449.30	5 460.7	614.90	N₂O₄, I (17)		2 448	382.3
		5 769.5	612.56	6 438	1 123	2 465	381.3
		5 790.5	612.45	N₂O, III (18)		2 536	377.4
		6 438.5	608.78	4 799.9	514.15	2 577	375.4
		6 707.8	607.52	5 085.8	512.08	2 676	371.0
				5 209.1	511.45		
				5 460.7	510.00		
				5 769.5	508.57		

C-Compounds.—C-Arrangement; v. Vol. III, p viii

CCl ₂ O, Carbonyl chloride (24)	
λ	r_0
White	1 159
CCl ₄ , Carbon tetrachloride (50,* 52)	
5 893	1 779
CS ₂ , Carbon disulfide (51)	
5 893	1 485
(43)	
5 893	1 478
6 710	1 457
CHCl ₃ , Chloroform (50,* 52)	
5 893	1 464
(43)	
5 893	1 442
6 708	1 435
CHN, Hydrocyanic acid (51)	
5 893	438
CH ₃ Br, Methyl bromide (50,* 52)	
5 893	964
CH ₃ Cl, Methyl chloride (50,* 52)	
5 893	870
CH ₃ F, Methyl fluoride (10)	
5 893	449
CH ₃ I, Methyl iodide (50,* 52)	
5 893	1 273
(64)	
5 893	1 265
6 708	1 253
CH ₄ , Methane I (44, 46)	
5 290	447.8
5 718	445.4
5 935	443.5
6 375	441.1
6 585	440.4
(30)	
4 359	450.5
5 461	443.5
5 780	441.9
6 435	438.7
I (35)	
$\alpha = 0.003670$	
4 359	447.5
5 461	440.7
5 895	439.1
6 709	436.7
65 570	419.2
86 784	450.1
CH ₄ O, Methyl alcohol (50,* 52)	
5 893	623
(64)	
5 893	552
6 708	550

* Data given with reserve.

C ₂ N ₂ , Cyanogen (31.1)	
λ	r_0
5 350	789
5 893	784
6 708	780
I (77)	
4 359	870.8
5 461	853.8
6 708	843.1
II (9)	
5 893	844.6
(48)	
5 893	820.2
C ₂ H ₂ , Acetylene I (44, 46)	
5 461	569.8
5 769	566.3
5 896	565.1
6 375	562.7
6 708	560.4
I (77)	
4 359	619.0
5 461	605.1
6 708	597.7
(52)	
5 893	610
C ₂ H ₃ N, Acetonitrile (50,* 52)	
5 893	776
C ₂ H ₄ , Ethylene I (45)	
5 230	662.0
5 461	661.4
5 790	658.8
5 896	657.1
6 185	653.1
6 677	651.6
(30)	
4 359	739.4
5 461	720.3
5 780	716.9
6 435	713.1
I (77)	
4 359	742.8
5 461	731.5
6 708	716.8
C ₂ H ₄ Cl ₂ , 1, 1-Dichloroethane (64)	
5 893	1 415
6 708	1 408
C ₂ H ₄ Cl ₂ , Ethylene chloride (50,* 52)	
5 893	1 417
(64)	
5 893	1 349
6 708	1 341
C ₂ H ₄ O, Acetaldehyde (50,* 52)	
5 893	811

* Data given with reserve.

C ₂ H ₅ Br, Ethyl bromide λ r_0	
(50,* 52)	
5 893	1 223
C ₂ H ₅ Cl, Ethyl chloride (50,* 52)	
5 893	1 179
C ₂ H ₅ I, Ethyl iodide (50,* 52)	
5 893	1 608
(43)	
5 893	1 646
6 708	1 632
C ₂ H ₆ , Ethane I (45, 46)	
5 230	756.8
5 461	756.6
5 790	754.2
5 896	752.8
6 185	750.9
6 677	747.8
I (77)	
4 359	782.4
5 461	769.0
6 708	762.9
C ₂ H ₆ O, Ethyl alcohol (50,* 52)	
5 893	885
(43)	
5 893	873
6 708	868
C ₂ H ₆ O, Methyl ether (50,* 52)	
5 893	891
C ₃ H ₄ , Allylene (50,* 52)	
5 893	1 188
C ₃ H ₅ Cl, 3-Chloropropylene (50,* 52)	
5 893	1 444
C ₃ H ₆ , Propylene (50,* 52)	
5 893	1 120
C ₃ H ₆ O, Acetone (50,* 52)	
5 893	1 100
(64)	
5 893	1 082
6 708	1 076

* Data given with reserve.

C ₃ H ₈ O ₂ , Ethyl formate λ r_0	
(50,* 52)	
5 893	1 191
(64)	
5 893	1 199
6 708	1 193
C ₃ H ₈ O ₂ , Methyl acetate (50,* 52)	
5 893	1 138
(64)	
5 893	1 193
6 708	1 187
C ₃ H ₇ I, Propyl iodide (64)	
5 893	1 788
6 708	1 775
C ₄ H ₈ O ₂ , Ethyl acetate (50,* 52)	
5 893	1 408
(43)	
5 893	1 586
6 708	1 578
C ₄ H ₈ O ₂ , Methyl propionate (64)	
5 893	1 477
6 708	1 469
C ₄ H ₁₀ O, Ethyl ether (50,* 52)	
5 893	1 544
(43)	
5 893	1 521
6 708	1 514
C ₅ H ₁₀ , Amylene (50,* 52)	
5 893	1 693
C ₅ H ₁₂ , Pentane (50,* 52)	
5 893	1 711
C ₆ H ₆ , Benzene (50,* 52)	
5 893	1 823
(80)	
5 893	1 820
(64)	
5 893	1 705
6 708	1 691

* Data given with reserve.

Mixtures

x = vol. % of second substance (or mixture); subscripts $_{\text{mix}}$, $_1$ and $_2$ refer to the mixture and to first and second substance, respectively. The refractivities are said to be additive if $(n - 1)_{\text{mix}} = (n - 1)_1 + x\{(n - 1)_2 - (n - 1)_1\}$. Reduced refractivity and density of the mixture are defined as $(n - 1)_r = (n - 1) \times \frac{760}{p} \cdot \frac{T}{273}$ and $d_r = d \cdot \frac{760}{p} \cdot \frac{T}{273}$.

Mixture	λ	Remarks	Lit.
Air.....		See Tables 1, 2, 3	
O ₂ + O ₃	4800 to 6708	Additive	(18)
NO ₂ + N ₂ O ₄	6438	$10^6(n - 1)_r = 298.34d_r - 105.33^*$	(17)
H ₂ + CO ₂	5780	Additive	(78)
H ₂ + (He + Ne)....	5780	Additive	(78)

* 272°K < T < 343°K; 55 mm < p < 238 mm.

TABLE 5.—DISPERSION FORMULAE FOR GASES AND VAPORS

$\lambda_\mu = 10^{-4}\lambda_A$; unit of $\lambda_A = 1 \text{ \AA}$. The table is divided into 4 sections, each, except *D*, devoted to a single type of formula. In general, the data refer to 0°C and 760 mm of Hg. Certain of the parameters depend upon the formula used in reducing the observations to 0° and 760 mm; these formulae are indicated by *I*, *II*, *III* (see Table 4) placed at head of section or in column (2).

$A. (n-1)10^6 = A + B\lambda_\mu^{-2} + C\lambda_\mu^{-4}$ (Formula I)						
(1)	A	B	C	1000B/A	10 ⁶ C/A	Lit.
A.....	277.826	1.558	0	5.608	0	(65)
H ₂ *.....	136.102	1.0246	0.009906†	7.5282	72.78	(33)
H ₂				7.337‡	89‡	(69, 72, 74)
O ₂	269.74	0.372	0.126	1.379	467	(66)
CO ₂				6.787§	-6.14§	(70, 71, 73)
Air.....	See Table 2					

* Those authors who use only *A* and *B*, find values of *B* varying from 0.90 to 1.00; see (14).

† Author uses a fourth term, $D\lambda_\mu^{-6}$; $D = 70.51 \times 10^{-6}$, $D/A = 5.181 \times 10^{-7}$.

‡ For all pressures between 25 and 70 atmospheres, $t = 20^\circ\text{C}$, $4050 \text{ \AA} < \lambda < 5090 \text{ \AA}$.

§ For all pressures between 20 and 47 atmospheres, $t = 12^\circ\text{C}$, $4050 \text{ \AA} < \lambda < 5090 \text{ \AA}$.

$$B. (n-1)10^6 = \beta'/(\mu' - \lambda_\mu^{-2}) + \beta''/(\mu'' - \lambda_\mu^{-2})$$

In most cases, β'' and $\mu'' = 0$; when β'' and μ'' are not zero, their values are written below those of β' and μ' , with which they are connected by {.

(1)	(2)	β	μ	Lit.
A.....	III	52 404	188.99	(16)
Br ₂	III	47 598	43.547	(18)
Cl ₂	III	81 257	106.993	(18)
H ₂	I	18 800	137.88	(14)
H ₂	I	{ 12 200.7 5 811.98 }	{ 118.637 175.327 }	(33)
He.....	III	13 470.9	388.80	(16)
Kr.....	III	59 385	141.866	(16)
N ₂	I	55 939	189.94	(14)
Ne.....	III	28 814	432.40	(16)
O ₂	I	37 744	142.27	(14)
Xe.....	III	68 010	99.754	(16)
H ₂ O.....	III	29 190	118.86	(18)
HCl.....	III	51 583	118.49	(18)
HBr.....	III	57 162	96.316	(18)
HI.....	III	64 333	72.849	(18)
SO ₂	III	63 640	99.21	(15)
H ₂ S.....	III	53 711	86.76	(15)
NO.....	III	39 122	135.73	(18)
N ₂ O.....	III	62 983	126.84	(18)
NH ₃	III	32 953	90.392	(18)
NH ₃	I	30 998	83.442	(47)
CO.....	III	40 452	123.60	(11)
CO ₂	I	69 049	156.63	(11)
CO ₂	III	68 524	156.63	(11)

$$C. \frac{3(n^2-1)}{2(n^2+2)}10^6 = \beta'/(\mu' - \lambda_\mu^{-2}) + \beta''/(\mu'' - \lambda_\mu^{-2}) \text{ (Formula I)}$$

(1)	β'	μ'	β''	μ''	Lit.
N ₂	39 534	152.294	-8 373.4*	-240.651*	(37)
CO ₂	74 203	172.400	485.22	45.038	(38)

* Note the minus sign here.

D. Miscellaneous formulae

H ₂	I	$(n^2-1)10^6 = 272.16 + 2.112/(\lambda_\mu^2 - 0.00776)$ (35)
He	I	$\frac{2}{3} \frac{n^2+2}{n^2-1} = 28 860.8 - \frac{67.763}{\lambda_\mu^2}$ (37)
O ₂	I	$(n^2-1)10^6 = 528.42 + 3.696/(\lambda_\mu^2 - 0.007000)$ (35)

* After correcting misprints in original article.

TABLE 6.—INDEX OF REFRACTION OF ISOTROPIC, NON-METALLIC SOLID AND LIQUID ELEMENTARY SUBSTANCES

Double refracting solids, p. 16; metals, Vol. V, p. 248. n = index of refraction; l = liquid; s = solid. Unit of $\lambda = 1 \mu = 10^{-4} \text{ cm}$. Temperature = t , °C.

(1)	λ	n	t	Lit.
Br <i>l</i>	D0.589	1.661	15	(29)
Cl <i>l</i>	D0.589	1.385	20	(22)
Cl <i>l</i>	D0.589	1.367	14	(6)
H <i>l</i>	0.579	1.0974	-252.83	(2)
I <i>s</i>	D0.589	3.34		(55)
N <i>l</i>	0.579	1.1975	-195.83	(2)
N <i>l</i>	D0.589	1.2053	-190	(40)
O <i>l</i>	D0.589	1.221	-181	(41, 42)
P <i>s</i> *.....	D0.589	2.1442	25	(27)
S <i>s</i> †.....	D0.589	1.998		(56)
S <i>l</i>	D0.589	1.929	110	(4)
S <i>l</i>	D0.589	1.890	130	(4)
Se <i>s</i> †.....	D0.589	2.92		(56)

* Yellow P. † Amorphous.

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Ahrberg, *Diss.*, Halle, 1909. (2) Augustin, *S*, 46: 419; 15. (3) Ayres, *2*, 2: 161; 13. (4) Becquerel, *6*, 12: 5; 77. (5) Bevan, *5*, 84: 209; 10. 85: 58; 11. (6) Bleekrode, *5*, 37: 339; 84. (7) Burton, *5*, 80: 390; 08. (8) Chappuis, *238*, 13: 07. (9) Chappuis and Rivière, *6*, 14: 5; 88.
- (10) Cuthbertson, *62*, 204: 323; 05. (11) Cuthbertson and Cuthbertson, *5*, 97: 152; 20. (12) Cuthbertson, *5*, 114: 650; 27. (13) Cuthbertson, *5*, 114: 659; 27. (14) Cuthbertson and Cuthbertson, *5*, 83: 151; 10. (15) Cuthbertson and Cuthbertson, *5*, 83: 171; 10. (16) Cuthbertson and Cuthbertson, *5*, 84: 13; 10. (17) Cuthbertson and Cuthbertson, *5*, 89: 361; 13. (18) Cuthbertson and Cuthbertson, *62*, 213: 1; 14. (19) Cuthbertson and Metcalfe, *5*, 90: 406; 08.
- (20) Cuthbertson and Metcalfe, *62*, 207: 135; 07. (21) Cuthbertson and Prideaux, *62*, 205: 319; 05. (22) Dechant, *57*, 5: 615; 84. (23) Dufet, in *Recueil de données numériques, optique I*. Paris, 1898. (24) Dulong, *6*, 31: 154; 1826. (25) Fox and Tate, *0*. (26) Fricke, *8*, 16: 865; 05. (27) Gladstone and Dale, *3*, 18: 30; 59. (28) Gruschke, *Diss.*, Breslau, 1910. (29) Howell, *2*, 6: 81; 15.
- (30) Kessler, *Diss.*, Halle, 1909. (31) Ketteler, *Theoretische Optik*. Braunschweig, Vieweg, 1885. (31.1) Ketteler, *Beobachtungen über die Farbenzerstreuung der Gase*. Bonn, 1865. (32) Ketteler, *8*, 124: 390; 65. (33) Kirn, *8*, 64: 566; 21. (34) Koch, *8*, 17: 658; 05. (35) Koch, *Nova Acta Reg. Soc. Sci. Upsaliensis*, 2: No. 5; 09. (36) Koch, *20*, 8: No. 20; 13. (37) Koch, *20*, 9: No. 6; 13. (38) Koch, *20*, 10: No. 1; 14. (39) Leduc, *34*, 123: 743; 96.
- (40) Liveing and Dewar, *3*, 36: 328; 93. (41) Liveing and Dewar, *3*, 34: 205; 92. (42) Liveing and Dewar, *3*, 40: 268; 95. (43) Lorenz, *8*, 11: 70; 80. (44) Loria, *165*, 1908A: 1059. (45) Loria, *165*, 1909A: 195. (46) Loria, *8*, 29: 605; 09. (47) Loria and Patkowski, *165*, 1913A: 494. (48) Mascart, *34*, 78: 617; 74. (49) Mascart, *34*, 78: 679; 74.
- (50) Mascart, *Ann. l'école norm.*, 6: 9; 77. (51) Mascart, *34*, 86: 321; 78. (52) Mascart, *34*, 86: 1182; 78. (53) Mathews, *143*, 177: 673; 14. (54) Meggers and Peters, *31A*, 14: 697; 18. (55) Meier, *8*, 31: 1017; 10. (56) Merwin and Larsen, *12*, 34: 42; 12. (57) Occhialini, *59*, 8: 123; 14. (58) Opladen, *96*, 42: 160; 27. (59) Pérard, *34*, 180: 49; 25.
- (60) Perreau, *6*, 7: 289; 96. (61) Phillips, *5*, 97: 225; 20. (62) Posejpal, *57*, 2: 85; 21. (63) Prideaux, *4*, 89: 316; 06. (64) Prytz, *8*, 11: 104; 80. (65) Quarder, *8*, 74: 255; 24. (66) Rentschler, *21*, 28: 345; 08. (67) Schacherl, *555*, No. 33; 23. (68) Scheel, *88*, 9: 24; 07. (69) Siertsema and de Haas, *64V*, 20: 624; 11.
- (70) Siertsema, *64V*, 21: 866; 12. (71) Siertsema, *63*, 14: 574; 13. (72) Siertsema and de Haas, *64P*, 14: 592; 12. (73) Siertsema and de Haas, *64P*, 15: 925; 13. (74) Siertsema and de Haas, *63*, 14: 568; 13. (75) Stasescu, *377*, 3: 211; 15. (76) Stasescu, *3*, 30: 737; 15. (77) Stuckert, *9*, 16: 37; 10. (78) Valentiner and Zimmer, *88*, 15: 1301; 13. (79) Walker, *62*, 201: 435; 03.
- (80) Wasastjerna, *138*, 2: No. 13: 24. (81) Zwetsch, *96*, 19: 398; 23. (82) Schacherl, *Faculty of Science, Univ. of Masaryk*, Publ. No. 98; 1928. (83) Schacherl, *Faculty of Science, Univ. of Masaryk*, Publ. No. 99; 1928. (84) Wetterblad, *Diss.*, Upsala, 1924.

REFRACTIVITY OF SELECTED SOLIDS AND LIQUIDS

CHARLES CHÉNEVEAU

Scope.—The substances included in this section are those pure solids and liquids which have been studied with special care on account of their practical importance or of some unusual behavior. All are listed in Table 1.

Sujet traité.—Les substances mentionnées dans cette section, sont les solides et liquides purs qui ont été étudiés avec un soin spécial, soit à cause de leur importance pratique, soit à cause de leur façon de se comporter inaccoutumée. Elles sont toutes mentionnées dans la Table 1.

Umfang.—Die in diesem Abschnitt enthaltenen reinen festen und flüssigen Stoffe sind solche, welche zufolge ihrer praktischen Bedeutung oder ihres ungewöhnlichen Verhaltens mit besonderer Sorgfalt studiert worden sind. Alle sind in der Tafel 1 angeführt.

Sostanze incluse.—Le sostanze incluse in questo capitolo sono quei solidi e liquidi puri che sono stati studiati con cura speciale sia per la loro importanza pratica o per il loro anormale comportamento. Essi sono riuniti nella Tabella 1.

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Units.—Unit of $\lambda = 1\mu = 10^4 \text{ \AA} = 10^{-4} \text{ cm}$; of $t = 1^\circ\text{C}$; of $p = 1 \text{ atm.}$; of $d = \text{g/cm.}^3$

TABLE 1.—REFRACTIVITY OF PURE SOLIDS AND LIQUIDS: SELECTED SUBSTANCES

$N_D[n_D]$ = index of refraction relative to vacuum [to air at 1 atm. and same temperature as the substance] for the Fraunhofer line D ($\lambda = 0.5893\mu$); similarly for n_C , n_F , etc.; $(10)^{-4} \Delta_{C-D} = (n_C - n_D)/(\lambda_C - \lambda_D)$, etc.; $(10)^{-5} \Delta_{tD} = (n_{t''} - n_{t'})/(t'' - t')$ for $\lambda = 0.5893(D)$; $\Delta\lambda$ = mean value of $dn/d\lambda$ throughout visible spectrum; $dn/dt = A_t(10)^{-6}$; $dN/dp = A_p(10)^{-6}$; C = crystal of cubic system; d = density; f = solidified from fusion; s = solid. Temperature (t) is 20°C , except as noted; $\lambda_C - \lambda_D = 0.0670\mu$, $\lambda_D - \lambda_F = 0.1032\mu$, $\lambda_F - \lambda_{G'} = 0.0520\mu$.

Substance		n_D	$-\Delta_{C-D}$	$-\Delta_{D-F}$	$-\Delta_{F-G'}$	Lit.	$-\Delta_{tD}$	$t', ^\circ\text{C}$	$t'', ^\circ\text{C}$	Lit.
H ₂ O	Water (<i>see</i> Table 2).....	1.3330	276	401	617		8	10	25	
NH ₄ Cl	Sal ammoniac.....	<i>s</i> 1.6422	$\Delta\lambda = -0.109$			(21)				
C	Diamond* (15°C).....	<i>s</i> 2.4173		1747		(67)	$(A_t)_D, 18^\circ = +19$			(56)
CCl ₄	Carbon tetrachloride.....	1.460	402	649	1057	(63)	50	11.1	25	(7)
CS ₂	Carbon disulfide†.....	1.629	1401	2412	4269	(6)	79	-20	+40	(26)
CHCl ₃	Chloroform.....	1.446	373	610	1038	(33)	55	18	30	(20)
CH ₂ O ₂	Formic acid.....	1.371	328	465	711	(23, 29)	43	19	21	(28)
CH ₃ I	Methyl iodide.....	1.530	805	1230	2192	(22)	78	16	29.5	(20)
CH ₄ O	Methyl alcohol.....	1.329	239	368	576	(9, 30)	36	18	30	(20)
C ₂ H ₄ Br ₂	Ethylene bromide.....	1.540	597	978	1634	(63)	57	0	35	(69)
C ₂ H ₄ O	Acetaldehyde.....	1.333	268	416	673	(22, 28)	60	6	12	(28)
C ₂ H ₄ O ₂	Acetic acid.....	1.372	298	445	711	(11, 15, 24)	51	18	26	(15)
C ₂ H ₅ I	Ethyl iodide.....	1.513	686	1133	1923	(22, 24)	69	10	20	(33)
C ₂ H ₅ O	Ethyl alcohol‡.....	1.361	268	416	653	(54)	40	0	45	(27)
C ₃ H ₆ O	Acetone§.....	1.359	283	455	750	(6, 24)	53	0	45	(27)
C ₃ H ₈ O	Isopropyl alcohol.....	1.377	283	436	692	(4)				
C ₃ H ₈ O ₃	Glycerol 	1.474¶	343**	532**	846**	(29, 32)	20	18	22	(29)
C ₄ H ₈ O ₂	Butyric acid.....	1.398	313	475	788	(4)	40	19	21.7	(65)
C ₄ H ₁₀ O	Butyl alcohol.....	1.399	298	475	711	(4)	41	15.5	80.2	(16)
C ₄ H ₁₀ O	Ethyl ether††.....	1.352	268	416	634	(6, 9)	59	0	35	(38)
C ₆ H ₁₂ O	Isoamyl alcohol.....	1.407	313	484	750	(4)	40	16	26	(9)
C ₆ H ₅ NO ₂	Nitrobenzene.....	1.553	1044	1773		(4)	51	25	38	(20)
C ₆ H ₆	Benzene†.....	1.501	701	1162	2000	(6)	64	12	30	(69)
C ₆ H ₆ O	Phenol.....	1.550	880	1279	2307	(29)				
C ₆ H ₇ N	Aniline.....	1.586	1013	1753	3153	(4)	54	11.2	90.1	(41)
C ₇ H ₈	Toluene‡‡.....	1.495	656	1114	1923	(6)	58	10	90	(41)
C ₈ H ₁₀	<i>o</i> -Xylene†.....	1.507	656	1104	1884		57	11	42	(5)
C ₈ H ₁₀ N ₂ O	<i>p</i> -Nitrosodimethylaniline.....	<i>s</i> 1.808		§§		(10)				
C ₁₀ H ₇ Br	Bromonaphthalene 	1.658	1313	2296	4211	(6)	46	16.5	77.6	(37)
C ₂₀ H ₂₀ ClN ₃	Fuchsin.....	<i>s</i> 2.64	<i>See</i> Table 5			(42, 44)				
C ₂₃ H ₂₆ ClN ₂	Malachite green.....	<i>s</i> 1.33	<i>See</i> Table 5			(42)				
C ₂₆ H ₃₂ ClN ₃	Hofmann violet.....	<i>s</i> 2.20	<i>See</i> Table 5			(42, 46)				
C ₂₇ H ₁₈ N ₄ O ₈ S	Diamond green.....	<i>s</i> 1.27	<i>See</i> Table 5			(43, 46)				
C ₂₉ H ₃₅ IN ₂ . ³ / ₂ H ₂ O	Cyanin.....	<i>s</i> 1.71	<i>See</i> Table 5			(42, 43)				
C ₃₀ H ₂₀ N ₄ .HCl	Magdala red.....	<i>s</i> 1.90	<i>See</i> Table 5			(42)				

TABLE 1.—(Continued)

Substance	Form	<i>t</i> , °C	<i>n_D</i>	−Δλ	Lit.
SiO ₂ ; see Vol. VI, p. 341					
Pb(NO ₃) ₂ ¶	<i>s</i> <i>C</i>		1.7820	0.197	(64)
AgCl.....	<i>s</i> <i>f, C</i>		2.061	0.290	(70)
AgBr.....	<i>s</i> <i>f, C</i>		2.253	0.470	(70)
AgI.....	<i>s</i> <i>f, C</i>		2.181	0.740	(70)
(NH ₄) ₂ SO ₄ ·Fe ₂ (SO ₄) ₃ · 24H ₂ O.....	<i>s</i> <i>C</i>		1.4848	0.081	(59)
(NH ₄) ₂ SO ₄ ·Cr ₂ (SO ₄) ₃ · 24H ₂ O.....	<i>s</i> <i>C</i>		1.4841	0.065	(59)
B ₂ O ₃	<i>s</i> <i>f</i>	15	1.4636	0.042	(1.1)
(NH ₄) ₂ SO ₄ ·Al ₂ (SO ₄) ₃ · 24H ₂ O*.....	<i>s</i> <i>C</i>	15 to 21	1.4594	0.052	(59)
CaF ₂ *.....	<i>s</i> <i>C</i>	18	1.4338	0.0284	(36, 55)
Ba(NO ₃) ₂	<i>s</i> <i>C</i>		1.5711	0.095	(64)
NaCl*.....	<i>s</i> <i>C</i>	18	1.5443	0.0804	
NaClO ₃ *.....	<i>s</i> <i>C</i>	19	1.5152	0.0458	(3)
Na ₂ B ₄ O ₇	<i>s</i> <i>f</i>	16	1.5147	0.070	(1.1)
Na ₂ SO ₄ ·Al ₂ (SO ₄) ₃ ·24- H ₂ O.....	<i>s</i> <i>C</i>		1.4388	0.044	(59)
KCl*.....	<i>s</i> <i>C</i>	18	1.4904	0.0705	
KBr.....	<i>s</i> <i>C</i>		1.5593	0.100	(64)
KI.....	<i>s</i> <i>C</i>		1.6666	0.169	(64)
K ₂ SO ₄ ·Fe ₂ (SO ₄) ₃ ·24H ₂ O	<i>s</i> <i>C</i>		1.4816	0.078	(59)
K ₂ SO ₄ ·Cr ₂ (SO ₄) ₃ ·24H ₂ O	<i>s</i> <i>C</i>		1.4813	0.0638	(59)
K ₂ SO ₄ ·Al ₂ (SO ₄) ₃ ·24- H ₂ O*.....	<i>s</i> <i>C</i>	21	1.4560	0.052	(59)

* See also Table 3.

† See also Table 4.

‡ For 99.7 to 99.9 % C₂H₅OH. For pure C₂H₅OH, $n^2 = 1.839 + \frac{0.006795}{\lambda^2 - 0.01716}$ if $0.215\mu < \lambda < 0.420\mu$. If $t' = 0^\circ$ and $t'' = 45^\circ$, $\Delta_{tC} = -40.3$, $\Delta_{tD} = -40.4$, $\Delta_{tF} = -41.0$, $\Delta_{tG'} = -41.5$ (27). If $\lambda = 0.5893$ (D), $A_p = +40$ at 10° ; $+42$, 20° ; $+44$, 25° ; $+45$, 27.5° (48).

§ If $t' = 0^\circ$ and $t'' = 45^\circ$, $\Delta_{tC} = -52.8$, $\Delta_{tD} = -53.0$, $\Delta_{tF} = -53.8$, $\Delta_{tG'} = -54.9$ (27).

|| If $\lambda = 0.5893$ (D), $A_p = +11$ at 20°C (26).

¶ For pure C₃H₅O₃; deduced by extrapolation from 94.6 % C₃H₅O₃.

** For glycerol of $d = 1.259$ g cm⁻³ at 20°C .

†† If $\lambda = 0.5893$ (D), $A_p = +60$ at 5° ; $+63$, 10° ; $+69$, 20° ; $+72$, 25° ; $+75$, 27.5°C (48).

‡‡ If $t' = 10^\circ$ and $t'' = 90^\circ$, $\Delta_{tC} = -57.2$, $\Delta_{tD} = -57.7$, $\Delta_{tF} = -59.2$ (41).

§§ *p*-Nitrosodimethylaniline, *p*-(CH₃)₂NC₆H₄NO, at 20°C (10):

λ	0.4878	0.5042	0.5189	0.5270(E)	0.5603	0.5857	0.6170	0.6497
<i>n</i>	2.146	2.024	1.957	1.926	1.847	1.813	1.785	1.762

||| If $t' = 16.5^\circ$ and $t'' = 77.6^\circ$, $\Delta_{tC} = -45.4$, $\Delta_{tD} = -46.1$; $\Delta_{tF} = -47.8$ (37).

¶¶ Isotopic Pb(NO₃)₂ at 20°C . Pb = 207.20, $n_D = 1.7815$; Urano-Pb = 206.41, $n_D = 1.7814$ (47).

TABLE 2.—REFRACTIVITY OF WATER (H₂O)

Variation with wave-length (λ), with temperature (t) and pressure (p), and with source. $N[n]$ = index of refraction with reference to vacuum [to air at 1 atm. and same temperature as the water]; met. r. = metallic reflection.

Variation with λ : Except as noted, $t = 20^\circ\text{C}$. At 18°C , $n^2 = -0.013414\lambda^2 + 1.76148 + \frac{0.0065438}{\lambda^2 - (0.11512)^2}$ if $0.224\mu < \lambda < 1.256\mu$.

Radiation			<i>n</i>	Radiation			<i>n</i>
<i>S</i>	λ			<i>S</i>	λ		
(12)				(17, 34, 57)			
	0.1151	met. r.		Cd ⁻	0.2144	1.40397	
Ag	0.1829	1.46379		Cd	0.2195	1.39883	
Al	0.1862	1.45343		Cd	0.2265	1.39257	
Al	0.1990	1.42572		Cd	0.2313	1.38878	

TABLE 2.—(Continued)

Radiation			<i>n</i>	Radiation			<i>n</i>
<i>S</i>	λ			<i>S</i>	λ		
(17, 34, 57)				Mean of many observers			
Au	0.2428	1.38103		Hg	0.5770	1.33342	
Cd	0.2573	1.37349		Hg	0.5790	1.33333	
Au	0.2676	1.36904		Na(D)	0.5893	1.33300	
Cd	0.2749	1.36637		H α (C)	0.6563	1.33115	
Al	0.3082	1.35671		Li	0.6708	1.33079	
Cd	0.3404	1.35044		K(A')	0.7682	1.32888	
Cd	0.3611	1.34738		(49)			
Mean of many observers					0.871	1.3270	
Al	0.3944	1.34366			0.943	1.3258	
Ca(H)	0.3968	1.34352			1.028	1.3245	
H γ (G')	0.4341	1.34035			1.130	1.3230	
Hg	0.4360	1.34030			1.256	1.3210	
Cd	0.4416	1.33981		Residual rays (51)			
Cd	0.4678	1.33815		CaF ₂	25.5 to 26	1.41	
Cd	0.4800	1.33750		NaCl	49.6 to 53.6	1.36	
H β (F)	0.4861	1.33714		KBr	75.6 to 86.5	1.41	
Cd	0.5338	1.33499		Electromagnetic (62)			
Tl	0.5350	1.33490			4 000	5.3	
Hg	0.5460	1.33447			27 000	9.0	

Variation with temperature (t) and pressure (p): $n_t = n_{20} - 10^{-5} \times [0.124(t - 20) + 0.1993(t^2 - 400) - 0.000005(t^4 - 160\,000)]$; $dn/dt = A_t(10)^{-6}$ (mean result of many observers). Values of dN/dp apply if 1.5 atm. $< p < 8$ atm.; $dN/dp = A_p(10)^{-6}$.

λ	0.4341	0.4861	0.5893	0.6563		0.5893
<i>t</i>	<i>n_{G'}</i>	<i>n_F</i>	<i>n_D</i>	<i>n_C</i>	− <i>A_t</i>	<i>A_p</i> *
−10	(Liquid H ₂ O)		1.3338†			(46, 48, 72)
0			1.3340		1	+16.8
+5			1.3339			+16.2
10	1.3411	1.3378	1.3337	1.3318	41	+15.8
15			1.3334			+15.4
20	1.34035	1.33714	1.33300	1.33115	79	+15.2
25			1.3325			+14.8
30	1.3392	1.3360	1.3320	1.3302	115	
40	1.3379	1.3347	1.3306	1.3288	148	
50	1.3364	1.3332	1.3290	1.3274	176	
60	1.3346	1.3315	1.3272	1.3257	197	
70	1.3325	1.3294	1.3252	1.3237	212	
80			1.3231		218	
90			1.3207			

Variation with source of water: Natural waters at 20°C (13, 60). For $\lambda = 0.5893$ (D), n is as follows: Pure distilled H₂O, 1.33300; city supply, Paris, 1.33304; river, Seine, 1.33305; ocean, Mediterranean, 1.337; H₂O saturated with CO₂ at 1 atm., 1.33297.

*At 18.2°C	$\lambda = 0.486$	0.589	0.686
	$A_p = 15.4$	15.2	15.1

† For liquid (undercooled) H₂O, n_D passes through a maximum (1.33412) between -1°C and -2°C (45).

TABLE 3.—REFRACTIVITY OF SOME REMARKABLE CUBIC CRYSTALS

Includes: Sylvite (KCl), rock salt (NaCl), fluorite (CaF₂), sodium chlorate (NaClO₃), diamond (C), ammonium alum [Al₂(SO₄)₃·(NH₄)₂SO₄·24H₂O] and potassium alum [Al₂(SO₄)₃·K₂SO₄·24H₂O]. For SiO₂, see Vol. VI, p. 341. n = index of refraction with reference to air at 1 atm. and same temperature as crystal; $A_t(10)^{-6} = dn/dt$; abs. = strong absorption; met. r. = metallic reflection. $n^2 = -k'(10)^{-7}\lambda^4 - k(10)^{-4}\lambda^2 + a + \frac{b_1(10)^{-3}}{\lambda^2 - \beta_1^2} + \frac{b_2(10)^{-3}}{\lambda^2 - \beta_2^2}$ if $0.185\mu < \lambda < 22.30\mu$. $n^2 = n_\infty^2 + \frac{M_1}{\lambda^2 - \lambda_1^2} + \frac{M_2}{\lambda^2 - \lambda_2^2}$ if $\lambda' < \lambda < \lambda''$.

TABLE 3.—(Continued)

Parameter	18°C		
	KCl*	NaCl†	CaF ₂
k'	1.67587	2.86086	28.94
k	5.13495	9.28584	32.055
a	2.174967	2.330165	2.03913
b_1	6.98382	5.343924	6.125
$100\beta_1^2$	2.555521	2.547407	0.0078925
b_2	8.344206	12.78635	
$100\beta_2^2$	1.190826	1.484985	
n_∞^2	4.5531	5.1790	6.0104
M_1	0.0150	0.018496	0.00612093
M_2	10 747	8 977	5 099.15
λ_1^2	0.0234	0.01621	0.008884
λ_2^2	4 517.1	3 149.3	1 258.47
λ'	0.434	0.434	0.185
λ''	22.30	22.30	9.4291

Radiation		KCl		NaCl		CaF ₂	
S	λ	n	n	A_t	n	A_t	
		(35)	(2, 8)	(36)	(19, 55)	(36)	
Al	0.18540	1.82704	1.89322		1.50989	— 2.96	
Al	0.19352	(abs.)	1.82800		1.50123	— 4.02	
Al	0.19898	1.72432	1.79570		1.49621	— 4.64	
Au	0.20821	1.68302	1.75403	+18.4	1.48885	— 5.82	
Cd	0.21443	1.66182	1.73210	+ 8.51	1.48460	— 6.37	
Cd	0.21946	1.64739	1.71700	+ 2.35	1.48150	— 6.55	
Cd	0.23128	1.62037	1.68825	— 7.57	1.47516	— 7.32	
Au	0.24280	1.60041	1.66699	—14.0	1.47009	— 7.70	
Cd	0.25730	1.58119	1.64608	—19.79	1.46480	— 8.11	
Cd	0.27486	1.56380	1.62690	—23.96	1.45967	— 8.55	
Au	0.29136	1.55134	1.61312	—26.3	1.45586	— 8.90	
Al	0.30821	1.54130	1.60190	—28.3	1.45257	— 9.21	
Cd	0.30436	1.52720	1.58605	—30.68	1.44774	— 9.61	
Cd	0.36117	1.52042	1.57842	—31.94	1.44535	— 9.79	
			(35)		(55)		
H δ (h)	0.41018	1.50901	1.56547	—33.4	1.44112	—10.04	
Cd	0.44157	1.50384	1.55962	—34.25	1.43920	—10.28	
Cd	0.50859	1.49614	1.55087	—35.17	1.43618	—10.56	
Na(D)	0.58930	1.49038*	1.54433	—36.22	1.43385	—10.89	
Li	0.67080	1.48663	1.54002	—36.5	1.43226		
K	0.76822	1.48374	1.53666		1.43093		
		(40)	(31, 39)		(31, 39)		
2D	1.1786	1.47821	1.53037		1.42786		
3D	1.7679	1.47579	1.52744		1.42502		
4D	2.3572	1.47465	1.52586		1.42198		
5D	2.9465	1.47373	1.52453		1.41822		
6D	3.5358	1.47295	1.52317		1.41379		
8D	4.7144	1.47102	1.51999		1.40238		
10D	5.8930	1.46870	1.51601		1.38719		
12D	7.0716	1.46591	1.51106		1.36805		
14D	8.2502	1.46263	1.50529		1.34444		
16D	9.4288	1.45875	1.49850		1.31612		
		(52, 53)	(52, 53)				
20D	11.786	1.44909	1.48182				
24D	14.143	1.43712	1.46055				
27D	15.911	1.42607	1.44103				
30D	17.679	1.41393					
	20.60	1.3882	1.3730				
	22.30	1.372	1.3403				
	51.2		(met. r.)				
	66.1	(met. r.)					
		(50)	(50)		(50)		
	57 000	2.17	2.40		2.60		
	τ^\dagger	9.50	11.28		17.14	mm	

TABLE 3.—(Continued)

Radiation		n			
S	λ	NaClO ₃ §	C, 15°C	Al Alum¶	
				NH ₄	K
		(t, 19°C)	(35)	(t, 13°C)	(3)
		(3)			
Cd	0.21443			1.54349	1.53825
Cd	0.21946			1.53782	1.53280
Cd	0.22650			1.53106	1.52615
Cd	0.23128	1.61586		1.52684	1.52209
Cd	0.25730			1.50943	1.50514
Cd	0.27486			1.50096	1.49675
Cd	0.31332		2.5254		
Cd	0.3261	1.54931			
Cd	0.34036		2.5008	1.48180	1.47814
Cd	0.36117	1.53917	2.4853	1.47799	1.47436
			(67)	(t, 15 to 21°C)	(58)
Ca(H)	0.39685		2.46476		1.46907
H(F, H β)	0.48615		2.43539	1.46481	1.46140
Na(D)	0.58930	1.51523	2.41734**	1.45939	1.45602††
		(t, 23°C)			
		(14)			
O(B)	0.6867	1.51163			
(a)	0.71734			1.45509	1.45175
O(A)	0.75938		2.40245		1.45057

* For KCl (35) at 18°C; $(A_t)_D = -35$. For visible spectrum, mean $dn/d\lambda = -0.0705$.

† In visible spectrum, mean $dn/d\lambda = -0.0804$.

‡ Thickness of plate used in finding n for the electromagnetic radiation ($\lambda = 57\,000\mu = 5.7\text{ cm}$) is $\tau\text{ mm}$.

§ For NaClO₃ (14) $(n_{23} - n_{19})/23 = -57 \times 10^{-6}$ per 1°C if $0.686\mu > \lambda > 0.486\mu$.

¶ Diamond.

¶ In visible spectrum, mean $dn/d\lambda = -0.052$.

** For diamond (56) at 15°C, $(A_t)_D = +19$.

†† At 21°C (56) $(A_t)_D = -14$.

TABLE 4.—REFRACTIVITY OF SOME REMARKABLE ORGANIC LIQUIDS

$$n^2 = -k\lambda^2 + a + \frac{b_1}{\lambda^2 - \beta_1^2}; n^2 = n_\infty^2 + \frac{M_1}{\lambda^2 - \lambda_1^2} \frac{dn}{dt} = A_t(10)^{-6}.$$

$10^{-6}\Delta_{\alpha} = (n_{\nu'\lambda} - n_{\nu\lambda})/(t'' - t'). \quad \frac{dN}{dp} = A_p(10)^{-6}; d = \text{density, abs.} = \text{strong absorption, met. r.} = \text{metallic reflection.}$

CS ₂				CS ₂ —(Continued)			
$t = 18^\circ, d = 1.266; k = 0.0003, a = 2.51516, b_1 = 0.041695, \beta_1^2 = 0.04731930, \text{ if } 0.260 < \lambda < 1.998 \text{ (34); } n_\infty^2 = 2.511, M_1 = 0.04736, \lambda_1^2 = 0.0334, \text{ limits of } \lambda \text{ not indicated (1).}$				λ	n	A_t	
	λ	n	A_t		(6)		
Al	0.2175	met. r.		Al	0.3944	1.704	— 900
Fe	0.260	2.160		H γ	0.4341	1.6766	— 870
Cd	0.2677	2.110	—1750	Cd	0.4416	1.673	— 860
Cd	0.2749	2.008	—1500	Cd	0.4678	1.661	— 840
Cd	0.2881	1.912		Cd	0.4800	1.656	— 830
Cd	0.2981	1.875		H β	0.4861	1.6544	— 830
Fe	0.304	1.852		Cd	0.5086	1.647	— 820
Sn	0.317	1.807		Cd	0.5338	1.640	— 810
Fe	0.321	abs.		(D)	0.5893	1.6295	— 800
Cd	0.3261	1.782*		H α	0.6563	1.6201	— 780
Zn	0.335	1.791*				(49)	
Cd	0.3610	1.740	— 960		0.8	1.607	
					1.0	1.598	
					1.5	1.588	
					2.0	1.585	
					5.8	met. r.	

* Anomalous dispersion (CS₂) from $\lambda = 0.3261$ to $\lambda = 0.355$.

CS ₂ .—(Continued)			
λ	$t, ^\circ\text{C}$	A_p	(48)
(D)	0.5893	5	+60
(D)	0.5893	10	+62
	0.486	15	+67
(D)	0.5893	15	+64
	0.686	15	+62
(D)	0.5893	20	+66
(D)	0.5893	25	+68
(D)	0.5893	27.5	+69
λ			Δn
$t', -20^\circ$;	G'	0.4340	-87.2
$t'', +40^\circ$	F	0.4861	-83.4
(26)	D	0.5893	-79.4
	C	0.6563	-77.9

C₆H₆, Benzene
 $d = 0.880$, $t = 20^\circ\text{C}$; $n_\infty^2 = 2.194$, $M_1 = 0.02409$, $\lambda_1^2 = 0.01714$, limits of λ not indicated (1).

λ	n	A_t
(57)		
(69)		
	0.1745 met. r.	
Cd	0.2763	1.625
Cd	0.2837	1.619
Cd	0.2881	1.612
Cd	0.2981	1.598
Cd	0.3081	1.587
Cd	0.3133	1.582
Cd	0.3261	1.570
Cd	0.3404	1.560
Cd	0.3466	1.556
Cd	0.3610	1.548
(6)		
H γ	0.4341	1.523 -670
Cd	0.4678	1.516
Cd	0.4800	1.514
H β	0.4861	1.513 -660
Cd	0.5086	1.509
(D)	0.5893	1.501 -650
H α	0.6563	1.496 -640
(49)		
	0.8	1.489
	1.0	1.485
	1.5	1.480
	1.85	1.478

C ₆ H ₆ .—(Continued)		
For $\lambda = 0.5893$ (D).		
$t, ^\circ\text{C}$	A_p	(48)
5	+46	
10	+47	
20	+51	
25	+52	
27.5	+53	
$t' = 12^\circ\text{C}$; $t'' = 30^\circ\text{C}$.		
λ		
G'	0.4340	-67.4
F	0.4861	-66.8
D	0.5893	-64.6
C	0.6563	-64.5

C₈H₁₀, Xylene
 Mixture of *o*-, *m*-, and *p*-;
 $d = 0.866$, $t = 20^\circ\text{C}$; $n_\infty^2 = 2.177$, $M_1 = 0.02037$, $\lambda_1^2 = 0.0246$, limits of λ not indicated (1).

λ	n	(57)
Cd	0.2981	1.586
Cd	0.3081	1.575
Cd	0.3133	1.570
Cd	0.3261	1.560
Cd	0.3404	1.550
Cd	0.3466	1.546
Cd	0.3610	1.539
(5)		
H γ	0.4341	1.517
Cd	0.4678	1.509
Cd	0.4800	1.507
H β	0.4861	1.507
Cd	0.5086	1.503
(D)	0.5893	1.496
H α	0.6563	1.492
(49)		
	0.8	1.486
	1.0	1.482
	1.5	1.477
	1.88	1.476

TABLE 5.—REFRACTIVITY OF DYES

All dyes in this table are isotropic solids which exhibit selective reflection. n is determined either by prism or by reflection, as indicated, and is with reference to air at the same (room) temperature. Designations of Fraunhofer lines are in italics; e.g. (D).

Fuchsin, C ₂₀ H ₂₀ ClN ₃		Fuchsin.—(Cont'd)		Fuchsin.—(Cont'd)	
λ	n	λ	n	λ	n
Prism (42, 44)		Prism (42, 44)		Reflection (68)	
		H γ	0.4341.04	(H)	0.3971.32
		Sr	0.4610.83		0.4251.00
		H β	0.4861.05	(G)	0.4310.95
		Tl	0.5351.95		0.4550.847
		(D)	0.5892.64	H β	0.4861.074
H δ	0.4101.17	Li	0.6712.34	(E)	0.5271.912
	0.4131.15		0.7032.30	(D)	0.5892.684
					0.6342.412

Fuchsin.—(Cont'd)		Diamond green.— (Cont'd)		Cyanin.—(Cont'd)	
λ	n	λ	n	λ	n
Reflection (68)		Prism (43)		Prism (42, 43)	
H α	0.6562.310				0.6452.23
(B)	0.6872.161				0.6562.19
(a)	0.7192.086	(E)	0.5171.41		0.6712.11
	0.7602.019		0.5271.31		0.7002.03
Malachite green, C ₂₃ H ₂₆ ClN ₂			0.5531.09		0.7031.98
Prism (42)		(D)	0.5891.27		
H δ	0.4101.28	H α	0.6562.01		Prism (71)
	0.4161.37	(a)	0.7192.42		0.3951.58
H γ	0.4341.38	Reflection (68)		H δ	0.4101.57
H β	0.4861.45	(G)	0.4311.46		0.4211.55
Tl	0.5351.16		0.4751.54		0.4401.52
(D)	0.5891.33	H β	0.4861.44		0.4551.47
Li	0.6712.50		0.5171.24		0.4671.42
	0.7032.49	(E)	0.5271.14		0.4841.35
Hofmann violet, C ₂₆ H ₃₂ ClN ₃			0.5531.03		0.4931.29
Prism (42, 66)		(D)	0.5891.27		0.4971.25
	0.3761.58	H α	0.6562.15		0.5041.17
	0.4031.47	(a)	0.7192.41		0.5081.12
	0.4231.45	Cyanin, C ₂₉ H ₃₅ N ₂ .1.5H ₂ O			0.6482.35
H γ	0.4341.32	Prism (42, 43)			0.6602.25
	0.4451.23				0.6682.19
H β	0.4860.86		0.2881.71		0.6852.12
Tl	0.5351.27		0.3501.70		0.7002.06
(D)	0.5892.20		0.3781.69		0.7232.02
	0.6502.42		0.4071.68	(A)	0.7451.97
Li	0.6712.53	H γ	0.4341.61		0.7651.93
	0.7032.57	(e)	0.4381.59	Magdala red, C ₃₀ H ₂₆ N ₄ .HCl	
Diamond green		Sr	0.4611.49	Prism (42)	
C ₂₇ H ₁₈ N ₄ O ₈ S		H β	0.4861.43	H δ	0.4101.76
Prism (43)			0.5051.28	H γ	0.4341.72
(G)	0.4311.48		0.5201.19	H β	0.4861.54
	0.4751.70	Tl	0.5351.20	Tl	0.5351.56
H β	0.4861.60		0.5401.25	D	0.5891.90
		(D)	0.5561.39	Li	0.6712.06
			0.5891.71		0.7032.06
			0.6201.94		

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Beequerel, *B85*, p. 531. (1.1) Bedson and Williams, *25*, **14**: 2549; 81.
 (2) Borel, *34*, **120**: 1404; 95. (3) Borel, *149*, **34**: 134; 95. (4) Brühl, *13*, **203**: 1; 80. (5) Brühl, *13*, **235**: 1; 86. *52*, **50**: 119; 94. (6) Brühl, *7*, **22**: 373; 97. (7) Bugarsky, *7*, **71**: 705; 10. (8) Carvallo, *B85*, p. 461. (9) Chéneveau, *6*, **12**: 145, 289; 07.
 (10) Crombez, *186*, **1919**: 875. (11) Damien, *Ann. école norm.*, **10**: 233; 81.
 (12) Duclaux and Jeantet, *51*, **2**: 346; 22. (13) Dufet, *191*, **8**: 171; 85.
 (14) Dussaud, *149*, **27**: 521; 92. (15) Eisenlohr, *7*, **75**: 585; 10. (16) Eykman, *70*, **12**: 268; 93. (17) Flatow, *8*, **12**: 85; 03. (18) Fricke, *8*, **16**: 865; 05. (19) Gifford, *5*, **70**: 329; 02.
 (20) Gladstone and Dale, *62*, **153**: 317; 63. (21) Grailich, *Krystallographisch-Optische Untersuchungen*, p. 76. Vienna, 1858. (22) Haagen, *8*, **121**: 117; 67. (23) Homfray, *4*, **87**: 1430; 05. (24) Hubbard, *7*, **74**: 207; 10. (25) Ketteler, *8*, **33**: 506; 88. (26) Ketteler, *8*, **35**: 662; 88. (27) Korten, *Diss.*, Bonn, 1890. (28) Landolt, *8*, **117**: 352; 62. (29) Landolt, *8*, **122**: 545; 64.
 (30) Landolt and Jahn, *7*, **10**: 289; 92. (31) Langley, *Ann. Ast. Obs. Smithsonian Inst.*, **1**: 1; 00. (32) Lenz, *91*, **19**: 297; 80. (33) Lorenz, *8*, **11**: 70; 80. (34) Martens, *8*, **6**: 603; 01. (35) Martens, *8*, **8**: 459; 02. (36) Micheli, *8*, **7**: 772; 02. (37) Nasini and Bernheimer, *36*, **15**: 59; 85. (38) Oudemans, *70*, **4**: 269; 85. (39) Paschen, *8*, **4**: 299; 01.
 (40) Paschen, *8*, **26**: 120; 08. (41) Perkin, *4*, **61**: 287; 92. (42) Pfäuger, *8*, **56**: 412; 95. (43) Pfäuger, *8*, **58**: 670; 96. (44) Pfäuger, *8*, **65**: 173; 98. (45) Pulfrich, *8*, **34**: 326; 88. (46) Quineke, *8*, **44**: 774; 91. (47) Richards and Schumb, *1*, **40**: 1403; 18. (48) Röntgen and Zehnder, *8*, **44**: 24. 91. (49) Rubens, *8*, **45**: 238; 92.
 (50) Rubens, *76*, **38**: 556; 17. (51) Rubens and Hollnagel, *26*, **12**: 83; 10. (52) Rubens and Snow, *8*, **46**: 529; 92. (53) Rubens and Trowbridge, *8*, **60**: 724; 97. (54) Rudolphi, *7*, **37**: 426; 01. (55) Sarasin, *149*, **10**: 303; 83.

(56) Sella, 22, 7 II: 300; 91. (57) Simon, 8, 53: 542; 94. (58) Soret, 149, 12: 553; 84. (59) Soret, 149, 13: 5; 85. (60) Soret and Sarasin, 34, 108: 1248; 89. (61) Stefan, 75, 63 II: 223; 71. (62) Tear, 143, 194: 685; 22. (63) Timmermans and Martin, Univ. Brussels, 0. (64) Topsøe and Christiansen, 6, 1: 5; 74. (65) Verschaffelt, 186, 27: 69;

94. (66) Verschaffelt and Crombez, 186, 2: 31; 20. (67) Walter, 8, 42: 505; 91. (68) Walter, *Die Oberflächen- oder Schillerfarben*. Braunschweig, Vieweg, 1895. (69) Weegmann, 7, 2: 218; 88. (70) Wernicke, 8, 142: 560; 71. (71) Wood, 8, 46: 380; 98. (72) Zehnder, 8, 34: 91; 88.

REFRACTIVITY OF BIREFRINGENT CRYSTALS

H. E. MERWIN

These tables have to do primarily with variations of refractive index with wave-length and temperature. For refractive indices at a single wave-length, for 2V or 2E, for orientations, etc., see Vol. I, p. 166, 279, 320; and (56, 81.1, 115, 116.1, 235.1). For dispersion of birefringence, see (59-62); for refractivity of metallic crystals, see Vol. V, p. 248; for isotropic substances, see Vol. I, p. 165 (cf. p. 106), Vol. VII, p. 12, and for elementary substances, see Vol. VII, p. 1.

Ces tables concernent principalement les variations de l'indice de réfraction avec la longueur d'onde et avec la température. Pour les indices de réfraction concernant une seule longueur d'onde, pour 2V ou 2E, pour les orientations, etc., voir Vol. I, p. 166, 279, 320; et (56, 81.1, 115, 116.1, 235.1). Pour la dispersion de la biréfringence, voir (59-62); pour le pouvoir réfractif des cristaux métalliques, voir Vol. V, p. 248; pour les substances isotropiques, voir Vol. I, p. 165 (cf. p. 106), Vol. VII, p. 12, et pour les éléments, voir Vol. VII, p. 1.

Diese Tafeln behandeln vor allem die Änderung des Brechungsindex mit der Wellenlänge und der Temperatur. Für die Brechungsindex einzelner Wellenlängen, für 2V oder 2E, Orientierung, etc., siehe Bd. I, S. 166, 279, 320; ferner (56, 81.1, 115, 116.1, 235.1). Für die Dispersion der Doppelbrechung, siehe (59-62); für das Brechungsvermögen von Metallkristallen, siehe Bd. V, S. 248; für isotropischen Stoffe, siehe Bd. I, S. 165 (cf. S. 106), Bd. VII, S. 12, und für Elemente, siehe Bd. VII, p. 1.

Queste tabella si riferiscono principalmente alle variazioni dell'indice di birifrangenza in funzione della lunghezza d'onda e della temperatura. Per gli indici di rifrazione ad una sola lunghezza d'onda, per 2V e 2E, per le orientazioni, ecc., vedi Vol. I, p. 166, 279, 320; e (58, 81.1, 115, 116.1, 235.1). Per la dispersione della birifrangenza, vedi (59-62); per la refrattività dei cristalli metallici, vedi Vol. V, p. 248; per le sostanze isotropiche, vedi Vol. I, p. 165 (cf. p. 106), Vol. VII, p. 12, e per le elementi, vedi Vol. VII, p. 1.

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LIST OF BIREFRACTING MINERALS IN TABLE 1

Those for which the dispersion of the index has been most accurately and extensively measured are indicated by a "(d)."

Name	Serial No., Table 1	Name	Serial No., Table 1
Acmite.....	209	Avogadrite.....	260.1
Adularia.....	261	Barite.....	(d)182
Afwillite.....	147	Barylite.....	187.1
Åkermanite.....	170	Beckelite.....	165
Albite.....	(d)218	Beryl.....	(d)120
Allactite.....	61	Beryllonite.....	222
Anatase.....	(d)14	Blödite.....	224
Andalusite.....	101	Boracite.....	134
Andesine.....	229	Borax.....	215
Anglesite.....	(d)19	Borgströmite.....	73
Anhydrite.....	137.1	Boussingaultite.....	123
Anorthite.....	159	Brookite.....	15
Apatite.....	(d)140	Brucite.....	121
Apophyllite.....	(d)267	Calamine.....	39
Aragonite.....	(d)141	Calcite.....	(d)142
Augite.....	169	Calomel.....	46

LIST.—(Continued)

Name	Serial No., Table 1	Name	Serial No., Table 1
Cancrinite.....	228	Diamond*.....	11.1
Carborundum.....	(d)13	Diopside.....	(d)169
Cassiterite.....	18	Diopside.....	52
Celestite.....	173	Dolomite.....	(d)168
Cerussite.....	25	Elpidite.....	207
Chalcanthite.....	49	Epididymite.....	223
Chrysoberyl.....	118	Epidote.....	161
Chrysolite.....	(d)131	Epsomite.....	(d)122
Cinnabar.....	48	Euclase.....	119
Clinzoisite.....	161	Eudialite.....	227
Colemanite.....	157	Feldspars.....	261
Copiapite.....	72	Finnemanite.....	23
Cordierite.....	(d)136	Forsterite.....	(d)126
Corundum.....	(d)97	Goethite.....	63
Cotunnite.....	18.1	Goslarite.....	32
Cyanite.....	99	Greenockite.....	42
Cyanochroite.....	249	Gypsum.....	(d)138
Danburite.....	158		

List.—(Continued)

Name	Serial No., Table 1	Name	Serial No., Table 1
Hambergite.....	(d)117 1	Orthoclase.....	(d)261
Hardystonite.....	150	Parisite.....	164
Hedenbergite.....	153	Penninite.....	135
Hematite.....	62	Phenacite.....	116
Hemimorphite.....	39	Phosgenite.....	27
Hornblende.....	166	Picromerite.....	264
Hussakite.....	113	Pirssonite.....	226
Hutchinsonite.....	57	Proustite.....	56
Ice.....	(d)1	Pyromorphite.....	22
Iceland spar.....	142	Pyroxene.....	169
Iodyrite.....	54	Quartz.....	(d)12
Klinozoisite.....	161	Realgar.....	9
Laboradorite.....	229	Rhomboclase.....	71
Lepidoerocite.....	64	Rinneite.....	271
Leucite.....	262	Rutile.....	16
Leucosphenite.....	231	Scapolite.....	162
Lorenzenite.....	207.1	Seheelite.....	156
Marialite.....	221	Siderite.....	76
Mascagnite.....	(d)5	Sillimanite.....	100
Meionite.....	162	Smithsonite.....	36
Melanterite.....	64.1	Soda niter.....	(d)191.1
Melilite.....	170	Sphalerite*.....	31.1
Mellite.....	98	Sphene.....	148
Mesolite.....	230	Spodumene.....	190
Miea.....	263	Sauroliite.....	(d)103
Microeline.....	261.1	Stibiotantalite.....	96
Mimetite.....	24	Stibnite.....	11
Moissanite.....	13	Sulfur.....	2
Molybdenite.....	92	Swedenborgite.....	216
Molybdophyllite.....	129	Syngenite.....	266
Monazite.....	106	Titanite.....	148
Monticellite.....	(d)154	Topaz.....	(d)102
Morenosite.....	85	Tourmaline.....	(d)225
Museovite.....	263	Tremolite.....	171
Narsarsukite.....	210	Trimerite.....	117
Natrolite.....	220	Vanadinite.....	95
Nephelite.....	217	Whewellite.....	143
Niter.....	(d)236	Willemite.....	(d)38
Nocerine.....	167	Wulfenite.....	93
Oligoclase.....	229	Zincite.....	(d)31
Olivine.....	(d)126	Zireon.....	(d)17

* Isotropic; for comparison only.

Accurate Dispersions.—The birefracting crystals for which the most accurate and extensive measurements of the dispersion of the refractive index have been made are these, and those which are marked “(d)” in the preceding list.

	No.		No.
Ammonium oxalate (C ₂ H ₈ N ₂ O ₄).....		KIO ₄	231.2
Rhamnose (C ₆ H ₁₂ O ₅ ·H ₂ O).....		K ₂ SO ₄	232
Saccharose (C ₁₂ H ₂₂ O ₁₁).....		K ₂ S ₂ O ₆	233
Co(NH ₄) ₂ (SO ₄) ₂ ·6H ₂ O.....	81	Mg(NH ₄) ₂ (SeO ₄) ₂ ·6H ₂ O.....	124
Cs ₂ S ₂ O ₆	293	(NH ₄) ₂ SO ₄	5
CuSO ₄ ·5H ₂ O.....	49	NaNO ₃ (ω).....	191.1
K ₂ Co(SO ₄) ₂ ·6H ₂ O.....	255	Ni(NH ₄) ₂ (SO ₄) ₂ ·6H ₂ O.....	87
KNO ₃	236	SrS ₂ O ₆ ·4H ₂ O.....	174
KClO ₄	231.1	ZnO.....	31

The measurements for quartz (12), epsomite (122), and calcite (142) extend into the ultra-violet; and those for quartz and calcite into the infra-red also. (Numbers refer to Table 1.)

TABLE 1.—REFRACTION OF BIREFRINGENT CRYSTALS

See also Figs. 1 and 2

Standard arrangement (Vol. III, p. viii); substances containing C but no element of key-number greater than 16 are given in section II (p. 29). For more exact wave-lengths corresponding to symbols in the λ-column, see Table 3; alphabetical list of minerals, p. 16.

Definitions.— $10^{-4}\delta\omega_D = \omega_\lambda - \omega_D$, etc.; $10^{-5}\tau_\omega = d\omega/dt$, etc.; also $10^{-5}\tau_\omega = (\omega_{t''} - \omega_{t'})/(t'' - t')$, etc., if observations have been made at only two temperatures. The two classes of τ are not distinguished; both are reduced to vacuum (see Table 4). For uniaxial crystals, ω = index of refraction for ordinary ray, ϵ = that for extraordinary ray; if $\omega < \epsilon$, the crystal is optically positive. For biaxial crystals, α , β , γ = principal indices of refraction, $\alpha < \beta < \gamma$. All indices of refraction are referred to air at the temperature of the crystal, usually room temperatures, except when expressed with τ thus: τ_ω , etc. $2V$ = interior optic

axial angle; $\tan^2 V = \left[\frac{1}{\alpha^2} - \frac{1}{\beta^2} \right] \pm 1$, the sign of the exponent being

so chosen as to make $\tan^2 V < 1$; if this sign is +, then the crystal and V are positive, in the contrary case they are negative. For rapid computation of V , see Wright's tables (236.2).

Range of Variation.—The observed range is indicated in one of the following ways, e.g.: $\omega_D = 2.534$ to 2.564 , $\omega_D = 2.534(64)$, $\omega_D = \begin{cases} 2.534 \\ 2.564 \end{cases}$.

Accuracy.—If final figure is probably inaccurate by 2 to 5 units, it is printed in small type. Tabulated dispersions (δ) probably do not depart from a smooth curve by more than 1.5 units in final figure unless that is printed in small type.

Data.—Observers have often placed more stress upon variations for a particular specimen than upon actual values and the purity of the material. Data for materials probably pure are indicated by P , those nearly pure by p . Unit of $\lambda = 10 \text{ \AA} = 1 \text{ m}\mu = 10^{-7} \text{ cm}$. Temperature = t , °C.

I. A–B-Table: Inorganic Substances; Standard Arrangement; v. Vol. III, p. viii

1. H₂O, Ice (59) P ; cf. Fig. 1

λ	ω = 1.3090, ϵ = 1.3104, $t = -3^\circ$
589D	$\delta\omega_D$
λ	
405Hg	93
436Hg	69
486F	39
492Hg	36+
546Hg	14
578Hg	3+
623Hg	−11
656C	−19+
691Hg	−27
706He	−30
$t = -3^\circ$ and -65° ; $\delta\epsilon_D = 1.01\delta\omega_D$; $\tau_\omega = \tau_\epsilon = -3.8$.	

2.—(Continued)

λ	α	β	γ
471He	2.010	2.101	2.3340
480Cd	2.004	2.093	2.3239
486F	1.999	2.087	2.3172
492He	1.996	2.084	2.3111
502He	1.991	2.077+	2.3021
508Cd	1.987	2.073	2.2959
535Tl	1.976	2.058	2.2757
561Pb	1.967	2.049	2.2600
588He	1.958	2.038	2.2463
589D	1.957	2.037+	2.2454
644Cd	1.944	2.023	2.2243
656C	1.942	2.019+	2.2203
668He	1.940	2.017+	2.2168
671Li	1.939+	2.017	2.2159
768A'	1.926	2.001	2.1936

2. S* (Rhombic form) (14, 60, 176, 179); P ; cf. Fig. 1

λ	α	β	γ
434G'	2.042	2.139	2.3914
436Hg	2.040	2.137	2.3878
447He	2.029	2.123	2.3682
468Cd	2.012	2.103	2.3384

For $8^\circ < t < 30^\circ$ and $\lambda = 535\text{Tl}$, $\tau_\alpha = -17$, $\tau_\beta = -23$, $\tau_\gamma = -28$; for $\lambda = 671\text{Li}$, $\tau_\alpha = -17$, $\tau_\beta = -21+$, $\tau_\gamma = -25+$ (179). $+2V_D = 69^\circ$ (41, 179); $(2V_F - 2V_C) < \pm 0.5^\circ$ (133).

* Data read from curves.

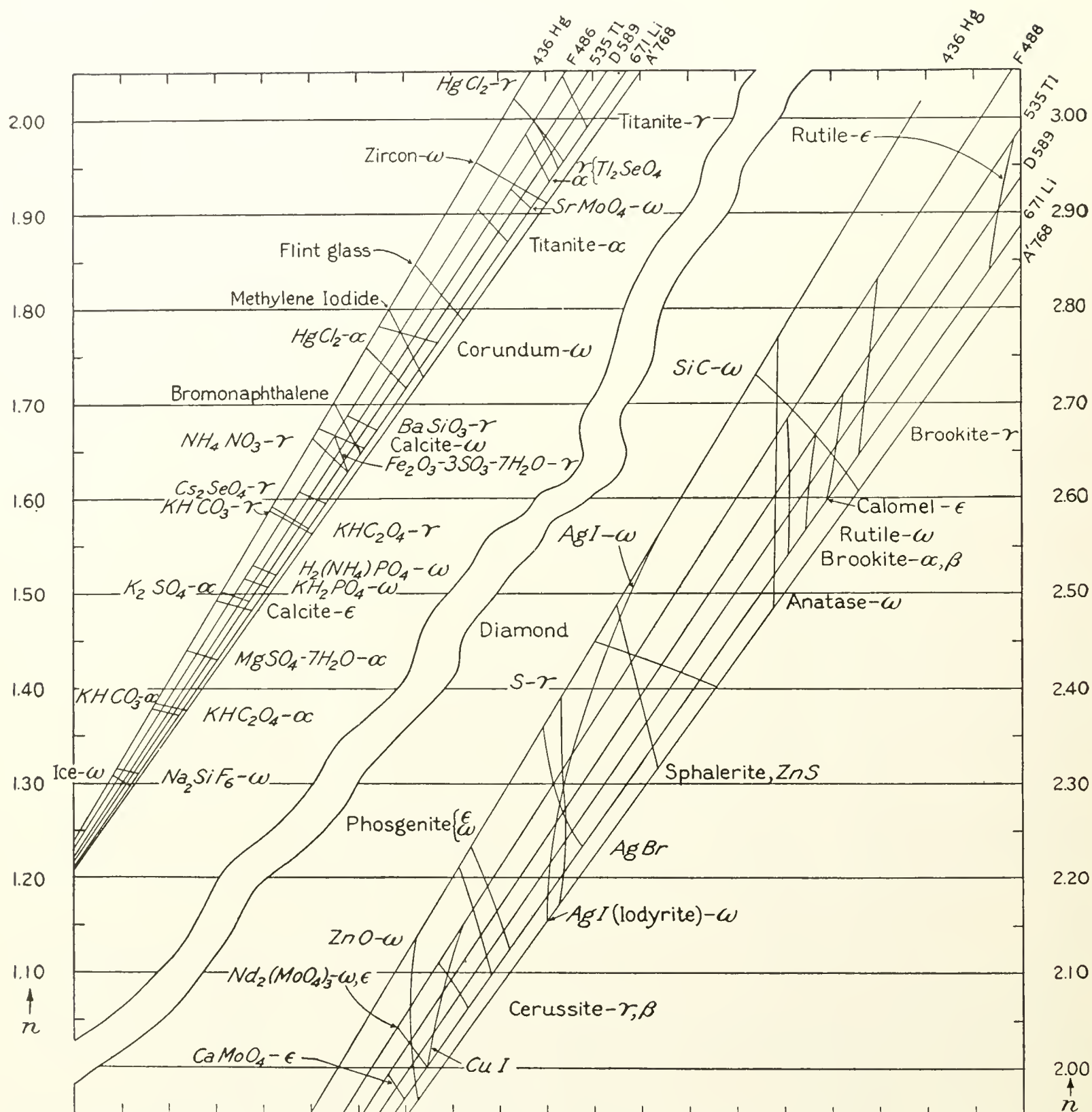


FIG. 1.—Dispersion curves for substances which are white when in the form of a fine dry powder. The lines of constant wave-length form a pencil diverging from $n = 1$; the values of λ corresponding to the six lines drawn are marked at their upper ends. With few exceptions, the curve for any substance covers the entire range of λ over which the index has been determined. A few isotropic substances are included for comparison.

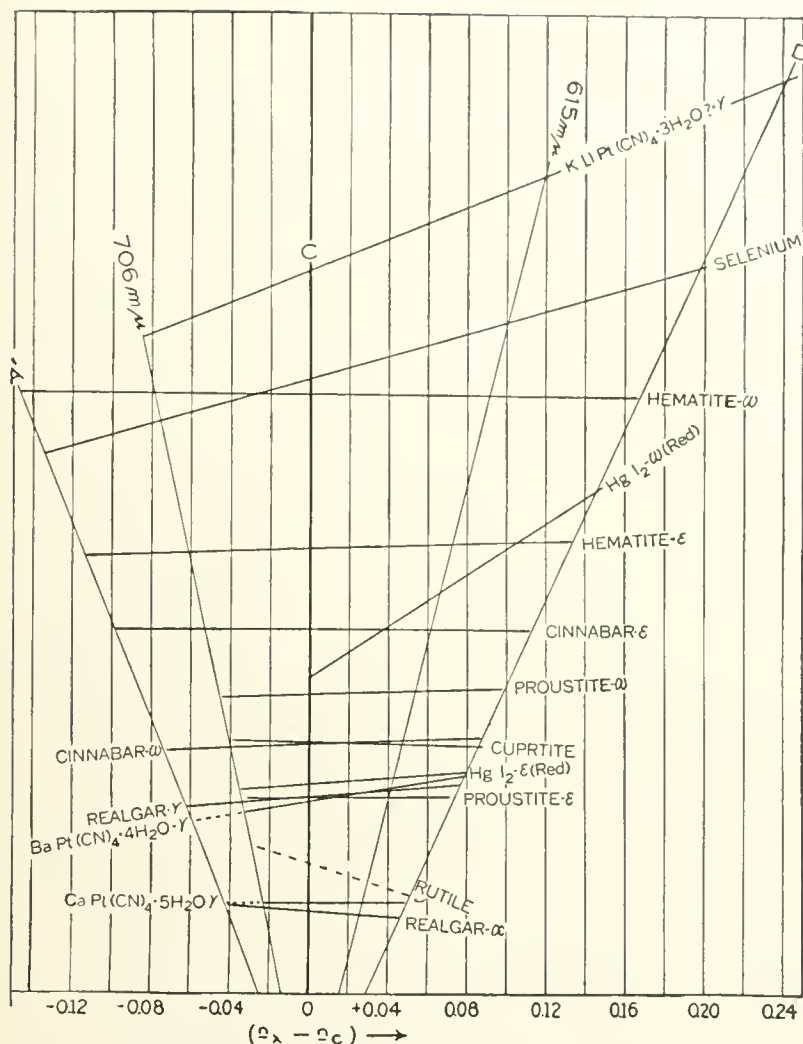


Fig. 2.—Dispersion curves for substances (rutile ϵ excepted) which are red, orange, or yellow when in the form of a fine dry powder. The lines (A' to D) of constant wave-length form a pencil diverging from a point on the line C, the abscissae are the values of the difference ($\text{Index}_\lambda - \text{Index}_C$), where $\lambda = A', D$, etc. Selenium is glassy, and cuprite (cuprtite in cut) is isotropic.

3. Se, (Hexagonal form) P
By transmission, $\omega_{680\text{m}\mu} = 3.0$,
($\epsilon - \omega$) $_{680\text{m}\mu} = 0.17$ (133)
By reflection (134.1, 184.1, 186)

λ	n_1^*	n_2^*
300	3.3	2.3
400	3.9	3.0
500	4.1	3.1
600	4.1	3.1
700	4.0	3.1

* Plane of incidence and electric vector \parallel principal axis of crystal for n_1 , \perp for n_2 . By comparison with transmission data, $n_2 = \omega$, $n_1 = \epsilon(?)$.

3.1. Te, (Hexagonal form)
(134.1, 222.1); P

λ	n_1^*	n_2^*
300	1.9	1.5
400	2.7	2.4
500	3.0	2.6
600	3.0	2.5
650	2.6	2.1

* Electric vector \parallel optic axis for n_1 , \perp for n_2 . By comparison with Se, $n_2 = \omega$, $n_1 = \epsilon(?)$.

3.2. NH_4ClO_4 (252); P

λ	α	β	γ
589D	1.4818	1.4833	1.4881
λ	$\delta\beta_D^*$	λ	$\delta\beta_D^*$
434G'	86	656C	-20

$\delta\alpha_D = 0.98 \delta\beta_D$; $\delta\gamma_D = 1.03 \times \delta\beta_D$; $2V_C = 69^\circ 34'$; $2V_F = 70^\circ 45'$.

* Curves, see 231.1.

4. NH_4NO_3 (133) P ; cf. Fig. 1

λ	α	β	γ
405Hg			1.6766
447He	1.4194	1.634+	1.6621
502He	1.4163+	1.623	1.6494
588He	1.4130	1.611+	1.6370
668He	1.4110+	1.605	1.6296

5. $(\text{NH}_4)_2\text{SO}_4$, Mescalinite
(208), δ (133); P

λ	α	β	γ
589D	1.5209	1.5230	1.5330
λ	$\delta\alpha_D$	λ	$\delta\alpha_D$
405Hg	138+	546Hg	21+
434G'	105	656C	-25
486F	59+	706He	-40+

$\delta\beta_D = 1.01 \delta\alpha_D$; $\delta\gamma_D = 1.05 \times \delta\alpha_D$; $+2V_D = 52^\circ$.

5.—(Continued)

For $15^\circ < t < 80^\circ$, $\tau_\alpha = -4.9$, $\tau_\beta = -4.0$, $\tau_\gamma = -6.2$; all colors.

6. $(\text{NH}_4)_3\text{H}(\text{SO}_4)_2$ (68); P

λ	α	β	γ
535Tl	1.504	1.509	1.535
589D	1.496	1.502	1.528
671Li	1.491	1.496	1.523

7. $(\text{NH}_4)_2\text{SeO}_4$ (210); P

λ	α	β	γ
589D	1.560	1.562	1.584
	1.561+	1.563+	1.585+
486F	1.5687	1.5713	1.5935
589D	1.5607	1.5630	1.5846
656C	1.5571	1.5594	1.5806

For $80^\circ < t < 100^\circ$, $\tau_\alpha = -1$, $\tau_\beta = -3+$, $\tau_\gamma = -4+$; all colors.

8. $(\text{NH}_4)_2\text{H}_2\text{PO}_4$ (200); p ; see Fig. 1

λ	ω	ϵ
486F	1.5314	1.4847
589D	1.5246	1.4792
656C	1.5212	1.4768

9. AsS, Realgar (230); see Fig. 2

λ	α	β	γ
545	2.584		
555	2.574		
570	2.558		2.741
575		2.707	2.728
590	2.538	2.684	2.704
610	2.521	2.656	2.675
640	2.502	2.626	2.643
680	2.482	2.594	2.613
710	2.468	2.575	2.594
740	2.458	2.560	2.578
750	2.456	2.556	

$-2V_{648} = 49.5^\circ$.

10. $(\text{NH}_4)_2\text{H}_2\text{AsO}_4$ (200); p

λ	ω	ϵ
486F	1.5859	1.5296
589D	1.5766	1.5217
656C	1.5721	1.5186

11. Sb_2S_3 , Stibnite (221)

λ		n_2	n_1
435		4.4	4.6
460		4.5	5.1
500		4.7	5.5
540		4.6	5.4
620		4.5	4.9
680		4.7	4.7
λ	α	β	γ
761	3.194*	4.046*	4.303*
823		3.919*	4.193*

* From (95).

11.1. C, Diamond; * see Fig. 1; for other carbon compounds, see p. 29

* Isotropic; included for comparison only.

12. SiO_2 , Quartz; P ; see Vol. VI, p. 341

13. SiC, Carborundum,* moissanite (229); cf. Fig. 1

λ	ω	ϵ
434G'	2.7313	2.7877
436Hg	2.7297	2.7859
455Ba	2.7138	2.7677
486F	2.6931	2.7442
492He	2.6894	2.7401
502He	2.6842	2.7342
546Hg	2.6632	2.7106
578Hg	2.6513	2.6974
588He	2.6481	2.6939
589D	2.6476	2.6933
656C	2.6296	2.6734
668He	2.6271	2.6707
706He	2.6195	2.6623
768A'	2.6098	2.6516

$\omega^2 = 0.83921 + 5.7099\lambda^2/(\lambda^2 - 161^2)$, unit of $\lambda = 1\text{m}\mu = 10 \text{ \AA}$.

t	$\left\{ \begin{array}{l} 20^\circ \\ 460^\circ \end{array} \right\}$	$\left\{ \begin{array}{l} 460^\circ \\ 760^\circ \end{array} \right\}$	$\left\{ \begin{array}{l} 760^\circ \\ 1150^\circ \end{array} \right\}$
λ	τ_ω		
471	7.50	10.0	
554	6.66	8.21	9.73
650	6.15	7.60	9.00
668	5.92	7.42	
λ	τ_ϵ		
471	8.20	11.5+	
668	6.36	8.08	

* Contains 0.77 % Fe; values for A', C, D, F and G' are by interpolation. Values of ω were computed by the equation given. For another specimen (126) ω and ϵ were about 0.006 greater.

14. TiO_2 ca., Anatase (59); cf. (14, 196, 237); cf. Fig. 1

λ	ω	ϵ
405Hg	2.8760	2.7395
436Hg	2.7688	2.6576
492Hg	2.6586	2.5691
546Hg	2.5955	2.5169
578Hg	2.5694	2.4950
589D	2.534(64)*	2.488(97)*
623Hg	2.5407	2.4709
691Hg	2.5106†	2.4456†
706He	2.5052†	2.4409†

t	$\left\{ \begin{array}{l} 25^\circ \\ 300^\circ \end{array} \right\}$	$\left\{ \begin{array}{l} 300^\circ \\ 450^\circ \end{array} \right\}$	$\left\{ \begin{array}{l} 450^\circ \\ 750^\circ \end{array} \right\}$
λ	τ_ω		
436	-1.8		
492	-2.4	-1.1	
546	-2.5	-1.4	-0.6
607	-2.4	-1.9	-1.1
691	-2.6	-2.0	-1.3

λ	τ_ϵ		
436	+0.4		
492	-0.6	+0.6	
546	-0.8	-0.1	+0.6
607	-1.3	-0.4	0.0
691	-0.8	-1.1	0.0

* From (14, 102, 178).

† Interpolated.

15. TiO_2 *ca.*, Brookite (196, 237, 250); *cf.* Fig. 1

λ	α	β	γ
436Hg	2.769	2.784	2.941
486F	2.680	2.685	2.820
535Tl	2.624	2.626	2.752
589D	2.583	2.584	2.700
656C	2.547	2.551	2.660
671Li	2.541	2.545	2.653

t	$\left\{ \begin{array}{c} 25^\circ \\ 300^\circ \end{array} \right\}$	$\left\{ \begin{array}{c} 300^\circ \\ 600^\circ \end{array} \right\}$	
-----	-----------------------------------------------------------------------	------------------------------------------------------------------------	--

λ	τ_b	τ_β
436	5.3	
492	3.0	3.0
546	2.1	2.1
579	1.9	1.9
671	1.4	1.1
708	1.3	0.9

λ	τ_a	τ_α
436	5.1	
492	3.7	3.7
546	2.4	2.4
579	2.4	2.4
671	2.0	1.8
708	1.7	1.5

λ	$\tau_c = \tau_\gamma$
492	-8.4
546	-9.1
579	-8.9
671	-8.9

16. TiO_2 *ca.*, Rutile (9); *cf.* Fig. 1 and Fig. 2. for ϵ

λ	ω	ϵ
535Tl	2.6725	2.9817
589D	2.6158	2.9029
671Li	2.5671	2.8415

t	$\left\{ \begin{array}{c} 25^\circ \\ 300^\circ \end{array} \right\}$	$\left\{ \begin{array}{c} 300^\circ \\ 450^\circ \end{array} \right\}$	$\left\{ \begin{array}{c} 450^\circ \\ 600^\circ \end{array} \right\}$
λ	τ_ω		
546	-5.1	-2.7	
579	-5.0	-3.1	-1.4
623	-4.6	-3.1	-2.0
691	-4.5	-3.0	

λ	τ_ϵ
546	-8.9
579	-7.7
623	-7.7

Range (9, 98, 162, 196); $\omega_D = 2.60+$ to $2.61+$; $\epsilon_D = 2.89$ to $2.90+$; $(\epsilon - \omega)_D = 0.286$ to 0.287 ; dispersion for ϵ (98, 196) 10% to 20% less than tabulated.

17. ZrSiO_4 *ca.*, Zircon (133); *cf.* (14, 64, 172, 190); *cf.* Fig. 1

λ	ω	ϵ
405Hg	1.9640	2.0239
434G'	1.9540	2.0139
436Hg	1.9535	2.0134
486F	1.9411	2.0007
492Hg	1.9401	1.9996
546Hg	1.9309	1.9902
589D	1.9254	1.9848
656C	1.9192	1.9782
768A'	1.9120	1.9708

17.—(Continued)

Range for zircon (64); $\omega_D = 1.878$ to 1.931 , $\epsilon_D = 1.895$ to 1.993 ; low values are uncommon. If $25^\circ < t < 1000^\circ$; in blue $\tau_\omega = +2.0$, $\tau_\epsilon = +2.1$; in red $\tau_\omega = +1.6$, $\tau_\epsilon = +1.8$ (64).

18. SnO_2 , Cassiterite (14)

λ	ω	ϵ
447He	2.0437	2.1345
486F	2.0260*	2.1193*
502He	2.0204	2.1144
588He	1.9983	2.0944
656C	1.9873	2.0842
668He	1.9858	2.0826

* Interpolated.

18.1 PbCl_2 , Cotunnite (56, 115)

λ	α	β	γ
589D	2.199	2.217	2.259
671Li	2.179	2.192	

19. PbSO_4 , Anglesite (61, 103, 111); *P*

λ	α	β	γ
589D	1.877(8)	1.882(3)	1.893(4)
λ	$\delta\beta_D$	λ	$\delta\beta_D$
405Hg	474+	546Hg	165
436Hg	342	656C	-74
486F	188+	706He	-116

$\delta\alpha_D = 0.99\delta\beta_D$; $\delta\gamma_D = 1.02\delta\beta_D$. If $-50^\circ < t < +550^\circ$, for $\lambda = 434G'$, $\tau_\alpha = -2.6$, $\tau_\beta = -2.1$, $\tau_\gamma = -3.5$; for $\lambda = 687B$, $\tau_\alpha = -3.0$, $\tau_\beta = -2.5$, $\tau_\gamma = -3.9$.

20. $\text{PbS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$ (167); *cf.* (17); *P*

λ	ω	ϵ
405Hg	1.6683	1.6865
436Hg	1.6589	1.6774
492Hg	1.6480	1.6672
546Hg	1.6400	1.6591
579Hg	1.6366	1.6557
623Hg	1.6335	1.6531
691Hg	1.6290	1.6486

21. $\text{Pb}_3(\text{PO}_4)_2$ (245); *p*

λ	ω	ϵ
486F	1.999	1.962
527E	1.985	1.949
589D	1.970	1.936
656C	1.959	1.926

22. $\text{Pb}_3\text{P}_3\text{O}_{12}\text{Cl}$, Pyromorphite (26)

λ	ω	ϵ
486F <i>ca.</i>	2.091	2.078
589D	2.061	2.049
656C <i>ca.</i>	2.050	2.042

23. $\text{Pb}_5\text{Cl}(\text{AsO}_3)_3$ (?), Finne-manite (4)

λ	ω	ϵ
486F	2.363	2.345
589D	2.295	2.285
656C	2.272	2.263

24. $\text{Pb}_5\text{As}_3\text{O}_{12}\text{Cl}$, Mimetite (26)

λ	ω	ϵ
486F <i>ca.</i>	2.186	2.170
589D	2.144	2.129
656C <i>ca.</i>	2.133	2.128

25. PbCO_3 , Cerussite (43, 144); *cf.* Fig. 1

λ	α	β	γ
589D	$\left\{ \begin{array}{c} 1.798 \\ 1.804 \end{array} \right\}$	$\left\{ \begin{array}{c} 2.073 \\ 2.076 \end{array} \right\}$	$\left\{ \begin{array}{c} 2.074 \\ 2.078 \end{array} \right\}$
λ	$\delta\alpha_D$	$\delta\beta_D$	$\delta\gamma_D$
486F	230	330	320
513	150	220	210
578	30	40	40
636	-60	-100	-100
656C	-80	-130	-130

26. $\text{Pb}(\text{CHO}_2)_2$ (Formate) (101); *cf.* (154); *P*

λ	α	β	γ
434G'	1.828+	1.904(1)	1.938
486F	1.811	1.878(80)	1.916
589D	1.789+	1.852(4)	1.887
656C	1.781+	1.843(1)	1.874+

27. $\text{PbO} \cdot \text{CO}_2 \cdot \text{PbCl}_2$, Phosgenite (14); *cf.* Fig. 1

λ	ω	ϵ
434G'	2.212	2.234+
447He	2.199	2.222
486F	2.167+	2.192+
502He	2.158	2.183
589D	2.118	2.145
656C	2.100	2.127+

28. Ti_2SO_4 (211); *P*

λ	α	β	γ
486F	1.8859	1.8935	1.9126
535Tl	1.8704	1.8778	1.8964
589D	1.8600	1.8671	1.8853
656C	1.8509	1.8579	1.8755
671Li	1.8493	1.8563	1.8739

29. Ti_2SeO_4 (211); *P*; *cf.* Fig. 1

λ	α	β	γ
486F	1.9840	1.9942	1.9987
535Tl	1.9635	1.9737	1.9782
589D	1.9493	1.9592	1.9640
656C	1.9355	1.9450	1.9500
671Li	1.9331	1.9426	1.9476

30. $\text{Ti}_2\text{C}_4\text{H}_4\text{O}_6$ (Tartrate) (84); *P*

λ	ω	ϵ
535Tl	1.7763	1.8218
589D	1.7677	1.8115
671Li	1.7583	1.8006

30.1. Zn (78.2); *P*

λ	n_1^*	n_2^*
455	1.00	0.78
486	1.35	1.09
520	1.47	1.32
560	1.92	1.61
589	2.58	2.02
630	2.47	2.27
650	2.47	2.07

* Electric vector \parallel optic axis for n_1 , \perp for n_2 .

31. ZnO , Zincite (133); *P*; *cf.* Fig. 1

λ	ω	ϵ
434G'	2.1395	2.1550
436Hg	2.1358	2.1513
447He	2.1143	2.1302

31.—(Continued)

λ	ω	ϵ
471He	2.0806	2.0971
486F	2.0649	2.0814
492He	2.0593	2.0759
502He	2.0515	2.0681
546Hg	2.0228	2.0394
589D	2.0041	2.0203
656C	1.9843	2.0003
668He	1.9817	1.9977
706He	1.9740	1.9898
768A'	1.9648	1.9806

31.1. ZnS , Sphalerite; * *P*; *see* Fig. 1

* Isotropic; for comparison only.

32. $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$, Goslarite (43.2, 200); *P*

λ	α	β	γ
486F	1.4620	1.4860	1.4905
589D	1.4568	1.4801	1.4844
656C	1.4544	1.4776	1.4820

33. $\text{ZnSeO}_4 \cdot 6\text{H}_2\text{O}$ (200)

λ	ω	ϵ
486F	1.5367	1.5108
589D	1.5291	1.5039
656C	1.5255	1.5004

34. $\text{Zn}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; *see* Table 235. $\text{Zn}(\text{NH}_4)_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; *see* Table 236. ZnCO_3 , Smithsonite* (137); *P*

λ	ω	ϵ
431G	1.8736	1.6326
486F	1.8621	1.6275
535Tl	1.8546	1.6241
589D	1.8485	1.6214
656C	1.8433	1.6190

* Sample 97.3% pure ZnCO_3 .

37. $\text{C}_9\text{H}_{20}\text{ON}_2 \cdot 2\text{HCl} \cdot \text{ZnCl}_2 \cdot 3\text{H}_2\text{O}$ (163)

Triacetonediamine dihydrochloride zinc chloride trihydrate

λ	α	β	γ
535Tl	1.570	1.574	1.603
589D	1.566	1.569	1.594
671Li	1.563	1.565	1.586

38. Zn_2SiO_4 , Willemite (61)

589D; $\omega = 1.6893$; $\epsilon = 1.7179$

λ	$\delta\omega_D$	λ	$\delta\omega_D$
405Hg	276	656C	-46
436Hg	199	706He	-73
486F	110	$\delta\epsilon_D = 1.04\delta\omega_D$	
546Hg	38		

39. $\text{Zn}_2\text{H}_2\text{SiO}_5$, Hemimorphite (calamine) (147)

If $-185^\circ < t < +13^\circ$, $\tau_{\alpha D} = +0.0$, $\tau_{\beta D} = +1.3$, $\tau_{\gamma D} = -0.2$. For birefringence and dispersion of 2V, *see* (184).

40. $\text{ZnSiF}_6 \cdot 6\text{H}_2\text{O}$ (200)

λ	ω	ϵ
486F	1.3860	1.3992
589D	1.3824	1.3956
656C	1.3808	1.3938

41. $\text{Ti}_2\text{Zn}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 241.1. $\text{Ti}_2\text{Zn}(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 242. CdS , Greenockite (124); P

λ	ω	ϵ
523	2.61	2.61
589D	2.506	2.529
671Li	2.431	2.456
700	2.411	2.436

43. $2\text{NH}_4\text{Cl} \cdot \text{CdCl}_2$ (177)

λ	ω	ϵ
527E ca.	1.6111	1.6114
589D	1.6038	1.6042
687B ca.	1.5958	1.5961

44. $\text{Cd}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 245. $\text{Cd}(\text{NH}_4)_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 246. HgCl_2 , Calomel (49); P ; cf. Fig. 1

λ	ω	ϵ
535Tl	1.9908	2.7129
589D	1.9732	2.6559
671Li	1.9556	2.6006

47. HgCl_2 (133); P ; cf. Fig. 1

λ	α	β	γ
589D	1.725	1.8590	1.965
λ	$\delta\beta_D$	λ	$\delta\beta_D$
434G'	443	656C	-92
486F	234		

$\delta\alpha_D = 0.80\delta\beta_D$; $\delta\gamma_D = 1.20 \times \delta\beta_D$.

47.1. HgI_2 (Red form) (133); see Fig. 2

λ	ω	ϵ
578		2.475
589D	2.748	2.455
593	2.732	
600	2.711	2.438
620	2.656	2.411
656C	2.600	2.375
671Li	2.582	2.363

48. HgS , Cinnabar (169); cf. (60); p ; see Fig. 2

λ	ω	ϵ
589.3D		3.275
599.0	2.903	3.256
607.5	2.887	3.238
623.9	2.865	3.209
643.9	2.842	3.178
672.0	2.816	3.143
707.7	2.789	3.107
762.1	2.760	3.068

48.—(Continued)

Range of t	λ	τ_ω
-110° to -50°		
-50° to $+12^\circ$		
12° to 77°		
77° to 142°		
142° to 200°		

λ	τ_ω
599	13
607	9
613	8
624	8
636	5
644	8
656	3
718	2

λ	τ_ϵ
577	30
589	19
607	21
613	20
624	17
636	11
644	14
656	9
691	7
718	8

48.1. CuI ; * see Fig. 1

* Isotropic; for comparison only.

49. $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, Chalcantith (81.1, 133); P

λ	α	β	γ
589D	1.5141	1.5368	1.5434
λ	$\delta\beta_D$	λ	$\delta\beta_D$
405Hg	167	656C	-31
434G'	125	671Li	-37
486F	70+	687B	-43+
535Tl	32		

$\delta\alpha_D = 0.92\delta\beta_D$; $\delta\gamma_D = 1.04 \times \delta\beta_D$.

50. $\text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 251. $\text{Cu}(\text{NH}_4)_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 252. $\text{CuSiO}_3 \cdot \text{H}_2\text{O}$, Diopside (98, 159); cf. (60)

λ	ω	ϵ
431G	1.683	1.742
486F	1.6697	1.7243
527E	1.6629	1.7160
589D	1.6580	1.7097

53. $\text{CuF}_6\text{Si} \cdot 6\text{H}_2\text{O}$ (200)

λ	ω	ϵ
486F	1.4138	1.4124
589D	1.4092	1.4080
656C	1.4074	1.4062

53.1. $\text{CuTi}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 253.2. $\text{CuTi}_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 253.3. AgBr ; see Fig. 154. AgI , Iodyrite, hexagonal (133); P ; cf. Fig. 1

λ	ω	λ	ω
434G'	2.584	546Hg	2.250
436Hg	2.557	578Hg	2.224
442.4	2.491	589D	2.218
457.6	2.409	656C	2.185
486F	2.328	768A'	2.154

If $F < \lambda < A'$, $\epsilon = \omega + 0.011$.

55. $\text{Ag}_2\text{S}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$ (200)

λ	α	β	γ
486F	1.6404	1.6748	1.6770
656C	1.6272	1.6573	1.6601

56. Ag_3AsS_3 ca., Proustite; see Fig. 2

γ	ω	ϵ	Lit.
589D	3.090+	2.794	(98)
589D	3.087+	2.792+	(41)
656C	2.991+	2.720	(98)
671Li	2.979	2.711+	(41)

Dispersion of (41) is 5% less than that of (98).

57. $\text{PbTiAgAs}_4\text{S}_8$ ca., Hutchin-sonite (187)

λ	α	β	γ
589D	3.08	3.176	3.188
656C	2.78	3.063	3.073

58. $\text{AuS}(\text{CH}_2\text{C}_6\text{H}_5)_2\text{Cl}$, Auro-dibenzylsulfine chloride (191)

λ	ω	ϵ
535Tl	1.774	1.717
589D	1.761	1.705
671Li	1.753	1.693

59. $\text{Mn}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 260. $\text{Mn}(\text{NH}_4)_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 261. $\text{Mn}_3(\text{AsO}_4)_2 \cdot 4\text{Mn}(\text{OH})_2$, Allactite (3)

λ	α	β	γ
486F	1.7633	1.7935	1.7937
527E			1.7869
589D			1.7788
656C	1.7552	1.7731	1.7732
687B			1.7704

Uniaxial for $\lambda = 573$.

61.1. $\text{MnSiF}_6 \cdot 6\text{H}_2\text{O}$ (200)

λ	ω	ϵ
486F	1.3605	1.3774
589D	1.3570	1.3742
656C	1.3552	1.3721

61.2. $\text{MnTi}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 261.3. $\text{MnTi}_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 262. Fe_2O_3 , Hematite (238); P ; see Fig. 2

λ	ω	ϵ
589D	3.22*	2.94*
656C	3.042	2.797
687B	2.988	2.759
719a	2.949	2.725
760A	2.904	2.690

* Extrapolated.

63. $\text{FeO} \cdot \text{OH}$, Goethite (154.1); P

λ	α	β	γ
589D	2.260	2.394	2.400
612*	2.245	2.377	2.377
671Li	2.218	2.342†	2.339†

* For $\lambda = 612$, $\beta = \gamma$, crystal is uniaxial.

† These correspond to same directions as the preceding, but, owing to changes in n , the first (2.342) is now γ and the second is β .

64. $\text{FeO} \cdot \text{OH}$, Lepidocrocite (154.1); P

λ	α	β	γ
589D	1.938	2.20	2.515
671Li	1.919	2.15+	2.425

64.1. $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, Melanterite (64.2); P

λ	α	β	γ
589D	1.4713	1.4782	1.4856
671Li	1.4681	1.4748	1.4824

65. $\text{Fe}_2\text{O}_3 \cdot 2\text{SO}_3 \cdot \text{H}_2\text{O}$ (154.2); P

λ	α	β	γ
486F	1.814	1.844	1.968
535Tl	1.796	1.821	1.940
589D	1.783	1.804	1.918
671Li	1.770	1.788	1.894

66. $\text{Fe}_2\text{O}_3 \cdot 2\text{SO}_3 \cdot 5\text{H}_2\text{O}$ (154.2); P

λ	α	β	γ
486F	1.603	1.702	1.787
535Tl	1.594	1.688	1.765
589D	1.588	1.678	1.749
671Li	1.580	1.667	1.733

67. $\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3$ (Orthorhombic form) (154.2); P

λ	α	β	γ
486F	1.844	1.857	1.861
535Tl	1.819	1.831	1.835
589D	1.802	1.814	1.818
671Li	1.785	1.797	1.801

68. $\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3$ (Rhombic form) (154.2); P

λ	ω	ϵ
486F	1.809	1.798
535Tl	1.786	1.775
589D	1.770	1.760
671Li	1.754	1.744

69. $\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 6\text{H}_2\text{O}$ (154.2); P

λ	α	β	γ
486F	1.624	1.656	1.681
535Tl	1.613	1.644	1.667
589D	1.605	1.635	1.657
671Li	1.597	1.626	1.646

70. $\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 7\text{H}_2\text{O}$ (154.2);
P; cf. Fig. 1

λ	α	β	γ
486F	1.585	1.603	1.666
535Tl	1.578	1.593	1.651
589D	1.572	1.586	1.640
671Li	1.565	1.578	1.629

71. $\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 9\text{H}_2\text{O}$, Rhomboclase (154.2); *P*

λ	α	β	γ
486F	1.545	1.564	1.657
535Tl	1.538	1.556	1.644
589D	1.533	1.550	1.635
671Li	1.528	1.544	1.625

72. $2\text{Fe}_2\text{O}_3 \cdot 5\text{SO}_3 \cdot 17\text{H}_2\text{O}$, Copiapite (154.2); *P*

λ	α	β	γ
486F	1.542	1.559	1.620
535Tl	1.536	1.552	1.606
589D	1.531	1.546	1.597
671Li	1.526	1.540	1.587

73. $3\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 9\text{H}_2\text{O}$, Borgströmite (154.2); *P*

λ	ω	ϵ
486F	1.865	1.755
535Tl	1.836	1.739
589D	1.816	1.728
671Li	1.797	1.716

74. $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 275. $\text{Fe}(\text{NH}_4)_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 276. FeCO_3 *ca.*, Siderite (94, 133)

λ	ω	ϵ
436Hg	1.9025	
486F	1.8893	
535Tl	1.8803	1.6356
546Hg	1.8783	
589D	1.8726	1.6321
656C	1.8658	
671Li	1.8645	1.6285

77. $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, Ferrous oxalate (133); *P*

λ	α	β	γ
486F	1.461	1.594	1.716
589D	1.455	1.580	1.690
656C	1.453	1.574	1.681

78. $\text{Fe}_2(\text{NH}_4)_6(\text{C}_2\text{O}_4)_6 \cdot 6\text{H}_2\text{O}$, Ferric-ammonium oxalate (133); *P*

λ	α	β	γ
486F	1.520	1.586	1.629
589D	1.510	1.570	1.610
656C	1.506	1.564	1.603

79. $\text{FeSiF}_6 \cdot 6\text{H}_2\text{O}$, Ferrous fluosilicate (50)

λ	ω	ϵ
535Tl	1.3656	1.3867
589D	1.3638	1.3848
671Li	1.3619	1.3828

79.1. $\text{FeTi}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 279.2. $\text{FeTi}_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 280. $\text{CoF}_2 \cdot 5\text{HF} \cdot 6\text{H}_2\text{O}$ (133); *P*

λ	ω	ϵ
434G'	1.390	1.406 +
589D	1.384	1.399
656C	1.382	1.397

81. $\text{Co}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 282. $\text{Co}(\text{NH}_4)_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 282.1. $\text{CoTi}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 282.2. $\text{CoTi}_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 283. $\text{NiF}_2 \cdot 5\text{HF} \cdot 6\text{H}_2\text{O}$ (130, 133); *P*

λ	ω	ϵ
434G'	1.398	1.413
589D	1.392 -	1.408 -
656C	1.390	1.406

84. $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ (200); *p*

λ	ω	ϵ
486F	1.5173	1.4930
589D	1.5109	1.4873
656C	1.5078	1.4844

85. $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$, Morenosite (43.1, 200); *p*

λ	α	β	γ
589D	1.4690	1.4892	1.4922
486F	$\delta\alpha_D = \delta\beta_D = \delta\gamma_D = 60; 2V_D = 41^\circ 55'$		

86. $\text{NiSeO}_4 \cdot 6\text{H}_2\text{O}$ (200); *p*

λ	ω	ϵ
486F	1.5473	1.5196
589D	1.5393	1.5125
656C	1.5357	1.5089

87. $\text{Ni}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 288. $\text{Ni}(\text{NH}_4)_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 289. $\text{NiSiF}_6 \cdot 6\text{H}_2\text{O}$ (200)

λ	ω	ϵ
486F	1.395	1.411
589D	1.391	1.407
656C	1.388	1.404

90. $\text{NiTi}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 291. $\text{NiTi}_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 292. MoS_2 , Molybdenite*

λ	ω
(221)	
500	5.6
555	5.0
593	4.7
620	5.4
655	4.9
680	5.9

92.—(Continued)

 $t = 18^\circ$ (38)

λ	ω
705	11.3
721	8.5
732	7.9
800	6.0
3000	4.0
7000	3.9

 $t = -190^\circ$ (38)

λ	ω
676	14.8
685	9.9
705	7.9
732	6.2

* See Vol. V, p. 250.

93. PbMoO_4 *ca.*, Wulfenite* (14)

λ	ω	ϵ
501.8	2.485	2.326
527.0	2.454†	
587.6	2.408 +	2.277
589.3D	2.405 + †	
667.8	2.372	2.257
686.7	2.362†	

* By (60) the birefringence is 0.007 to 0.009 less than that tabulated.

† By (98) 0.002 + lower than values by (14).

94. $(\text{NH}_4)_2\text{UO}_2(\text{C}_2\text{H}_3\text{O}_2)_3$, Ammonium-uranyl acetate (177); *p*

λ	ω	ϵ
527E <i>ca.</i>	1.4862	1.4987
589D	1.4808	1.4933
687B <i>ca.</i>	1.4754	1.4877

94.1. $(\text{NH}_4)_2\text{UO}_2\text{Cl}_4 \cdot 2\text{H}_2\text{O}$ (142.1)

λ	ω	ϵ
589D	2.358	2.311
656C	2.341	2.292

96. $(\text{SbO})_2(\text{Ta, Cb})_2\text{O}_6$, Stibiotantalite (149)

λ	α	β	γ
39% Ta_2O_5 and 17.5% Cb_2O_5			
535Tl	2.4014	2.4342	2.4876
589D	2.3742	2.4039	2.4568
671Li	2.3470	2.3750	2.4275
22.5% Ta_2O_5 and 30% Cb_2O_5			
535Tl	2.4261	2.4508	2.4903
589D	2.3977	2.4190	2.4588
671Li	2.3686	2.3876	2.4280

97. Al_2O_3 , Corundum (27, 122); *P*; cf. Fig. 1589D, $\omega = 1.768$, $\epsilon = 1.760$

λ	$\delta\omega_D$ (133)	λ	$\delta\omega_D$ (133)
436Hg	138	656C	-33
486F	76	706He	-51
546Hg	27		

 $\delta\epsilon_D = 0.97\delta\omega_D$; $\omega_D - \epsilon_D = 0.0081$ (27, 122).98. $\text{Al}_2\text{C}_{12}\text{O}_{12} \cdot 18\text{H}_2\text{O}$, Mellite (177)

λ	ω	ϵ
527E <i>ca.</i>	1.5435	1.5146
589D	1.5393	1.5110
687B <i>ca.</i>	1.5345	1.5079

99. $\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$, Cyanite (196)

λ	α	β	γ
589D	1.713	1.722	1.728
$\lambda \dots \dots$	434G'	486F	656C
$\delta\beta_D$ (133)	133	74	-29
$\delta\alpha_D = \delta\gamma_D = \delta\beta_D$; $-2V = 80^\circ$ <i>ca.</i> (196).			

100. $\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$, Sillimanite (133); *p*; specimen contains 0.5% Fe

λ	α	β	γ
589D	1.661	1.662	1.682 +
$\lambda \dots \dots$	436Hg	486F	656C
$\delta\beta_D \dots$	136	76	-32
$\delta\alpha_D = \delta\gamma_D = \delta\beta_D$; ranges (121, 188, 196): $\alpha_D = 1.653$ (61), $\gamma_D = 1.675$ (84), $+2V_D = 26$ to 31° .			

101. $\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$, Andalusite (196)

λ	α	β	γ
486F	1.639	1.645	1.651
589D	1.633	1.639	1.644
656C	1.630	1.636	1.641

102. $\text{Al}_2\text{F}_2\text{SiO}_4$, Topaz; (OH and Fe replacements) (139, 143, 150)

λ	$\delta\beta_D^*$	λ	$\delta\beta_D^*$
397H	138	589D	0
405Hg	129	656C	-23
434G'	97	706He	-36
486F	54	768A'	-51
$\delta\alpha_D = \delta\gamma_D = \delta\beta_D$; $\beta_D = 1.610$ (33), $\beta_D - \alpha_D = 0.0014$ (28), $\gamma_D - \beta_D = 0.0068$, $+2 \times V_C = 49$ to 67° , $2V_F = (2V_C - 2^\circ)$.			
λ	τ_α	τ_β	τ_γ
0 to 150° (143)			
480	0.75	0.85	0.79
671	0.77	0.77	0.77
150 to 300° (143)			
480	1.00	1.05	0.95
671	0.90	0.93	0.90

* Variations from 0.97 to 1.08 times these values are observed (171, 80, 133).

103. $4\text{FeO} \cdot 9\text{Al}_2\text{O}_3 \cdot 8\text{SiO}_2 \cdot \text{H}_2\text{O}$ *ca.*, Staurolite (91); specimen contained *ca.* 2% Fe_2O_3

λ	α	β	γ
589D	1.7440	1.7497	1.7561
λ	$\delta\beta_D$	λ	$\delta\beta_D$
431G	166	656C	-38
486F	89	687B	-53
527E	48		
$\delta\alpha_D = 0.97\delta\beta_D$; $\delta\gamma_D = 1.07\delta\beta_D$.			

104. $\text{Yt}_2(\text{MoO}_4)_3$ (245); *P*

λ	$\omega (= \epsilon)$
535Tl	2.042
589D	2.027
671Li	2.012

105. $\text{Ce}_2(\text{MoO}_4)_3$ (245); *P*

λ	ω	ϵ
535Tl	2.050	2.037
589D	2.034	2.022
671Li	2.018	2.006

106. $\text{CeLa}(\text{PO}_4)_2$, Monazite (34, 172, 174)

λ	α	β	γ
589D	1.789	1.790	1.843
	1.800	1.801	1.849
λ	$\delta\alpha_D$	$\delta\beta_D$	$\delta\gamma_D$
535Tl	55	55	65
671Li	-57	-57	-64

+2*V_D* = 11 to 15.5°.107. $\text{Pr}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ (51); *P*

λ	α	β	γ
535Tl	1.5430	1.5525	1.5641
589D	1.5399	1.5494	1.5607
671Li	1.5366	1.5459	1.5573

108. $\text{Pr}_2(\text{MoO}_4)_3$ (245); *P*

λ	535Tl	589D	671Li
ϵ	2.015	2.002	1.989

Opt.—; probably $\omega = \epsilon$ ca., cf. 111, $\text{Nd}_2(\text{MoO}_4)_3$.109. $\text{Nd}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ (51); *P*

λ	α	β	γ
535Tl	1.5441	1.5534	1.5652
589D	1.5413	1.5505	1.5621
671Li	1.5379	1.5469	1.5583

110. $(\text{Nd}, \text{Pr})_2(\text{MoO}_4)_3$ (245)

λ	486F	535Tl	589D	671Li
ω	2.054	2.037	2.025	2.011

 $(\omega - \epsilon) > 0$, but very small.111. $\text{Nd}_2(\text{MoO}_4)_3$ (245); *P*; cf. Fig. 1

λ	ω	ϵ
486F	2.047	2.045
535Tl	2.029	2.027
589D	2.016	2.014
671Li	2.003	2.001

112. $\text{Sa}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ (51); *P*

λ	α	β	γ
535Tl	1.5458	1.5551	1.5663
589D	1.5427	1.5519	1.5629
671Li	1.5395	1.5486	1.5594

113. $3[(\text{Yt}, \text{Er})_2\text{O}_3] \cdot 3\text{P}_2\text{O}_5 \cdot \text{SO}_3$, Hussakite (108)

λ	ω	ϵ
535Tl	1.7244	1.8196
589D	1.7207	1.8155
671Li	1.7166	1.8113

114. $\text{BeSO}_4 \cdot 4\text{H}_2\text{O}$

For dispersion (200)

λ	ω	ϵ
486F	1.4779	1.4450
589D	1.4720	1.4395
656C	1.4691	1.4374

114.—(Continued)

For birefringence (241)

λ	ω	ϵ
486F	1.477	1.437
589D	1.4714	1.4322
656C	1.4686	1.4299

115. $\text{BeSeO}_4 \cdot 4\text{H}_2\text{O}$ (200); *p*

λ	α	β	γ
486F	1.4725	1.5084	1.5101
589D	1.4667	1.5007	1.5027
656C	1.4639	1.4973	1.4992

116. Be_2SiO_4 , Phenacite (143)

λ	ω	ϵ
480Cd	1.6607+	1.6767+
508Cd	1.6586	1.6745
538Cd	1.6566+	1.6725+
589D	1.6539+	1.6697+
644Cd	1.6515+	1.6673+
671Li	1.6506	1.6664

Interval	λ	τ_ω	τ_ϵ
0 to 150°	480	1.0+	1.0+
	671	1.0	1.0
150 to 300°	480	1.2	1.2
	671	1.1+	1.1+

117. $\text{Mn}_2\text{Be}_2\text{SiO}_4$, Trimerite (32)

λ	α	β	γ
535Tl	1.719	1.725	1.729
589D	1.715	1.720	1.725
671Li	1.712	1.717	1.722

117.1. Be_2HBO_4 , Hambergite (59, 78)

λ	α	β	γ
589D	1.5595	1.5908	1.6311
	1.5530	1.5864	1.6272

2*V_F* - 2*V_C* = 9' - 50'

λ	$\delta\beta_D$	λ	$\delta\beta_D$
404Hg	149	546Hg	+21+
436Hg	106	691Hg	-36
492Hg	57	760	-55

 $\delta\alpha_D = 0.88\delta\beta_D$; $\delta\gamma_D = 1.10\delta\beta_D$ 118. $\text{BeO} \cdot \text{Al}_2\text{O}_3$, Chrysoberyl (121)

λ	α	β	γ
535Tl	1.7487	1.7516	1.7576
589D	1.7452	1.7481	1.7540
671Li	1.7412	1.7440	1.7498

119. $2\text{BeO} \cdot \text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot \text{H}_2\text{O}$, Euclase (227)

λ	α	β	γ
447He	1.6606	1.6653	1.6814
502He	1.6560	1.6605	1.6767
588He	1.6508	1.6553	1.6714
668He	1.6474	1.6521	1.6677

120. $\text{Be}_3\text{Al}_2\text{Si}_5\text{O}_{18}$ ca., Beryl (44, 133, 143)

λ	ω	ϵ
404Hg	1.5917	1.5846
447He	1.5869	1.5800
502He	1.5826	1.5757
588He	1.5778	1.5711
668He	1.5746	1.5682
768A'	1.5717	1.5654

120.—(Continued)

Range (57, 113, 172): Dispersion ca. 15%, birefringence ca. 0.003, ω and ϵ ca. 0.025.

Interval	λ	τ_ω	τ_ϵ
0 to 150° (143)	480	1.2+	1.2
	671	1.2	1.1
150 to 300°	480	1.4	1.3
	671	1.3+	1.2+

120.1. Mg (78.2)

λ	n_1^*	n_2^*
416	0.26	0.31
440	0.29	0.34
496	0.29	0.37
520	0.33	0.39
560	0.38	0.42
589	0.34	0.39
620	0.32	0.42
650	0.32	0.42

* Electric vector \parallel optic axis for n_1 , \perp for n_2 ; by comparison with Se, $n_2 = \omega$ and $n_1 = \epsilon$ (?).121. $\text{Mg}(\text{OH})_2$, Brucite (233); cf. (59)

λ	ω	ϵ
20°C		
447He	1.5794	1.5949
502He	1.5730	1.5902
588He	1.5662	1.5853
589D	1.561*	1.581*
706He	1.5617	1.5815
100°C		
502He	1.5730	1.5897
588He	1.5662	1.5848
706He	1.5616	1.5808
200°C		
502He	1.5720	1.5883
588He	1.5654	1.5835
706He	1.5607	1.5794

* From (102.1).

122. $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, Epsomite (21, 200); *P*; cf. Fig. 1

λ	α	β	γ
226Cd	1.4990	1.5266	1.5326
231Cd	1.4950	1.5223	1.5284
257Cd	1.4786	1.5049	1.5109
275Cd	1.4705	1.4963	1.5023
340Cd	1.4528	1.4774	1.4832
347Cd	1.4516	1.4762	1.4820
361Cd	1.4492	1.4736	1.4794
434G'	1.4406*	1.4644*	1.4701*
486F	1.4370*	1.4604*	1.4660*
589D	1.4322*	1.4553*	1.4608*
589D	1.4323	1.4553	1.4607
656C	1.4300*	1.4528*	1.4583*

-2*V_D* = 51° 25'.

* Recalculated from data of (43.2, 200).

123. $\text{Mg}(\text{NH}_4)_2(\text{SO}_4) \cdot 6\text{H}_2\text{O}$, Boussingaultite; see Table 2124. $\text{Mg}(\text{NH}_4)_2(\text{SeO}_4) \cdot 6\text{H}_2\text{O}$; see Table 2125. $\text{MgC}_4\text{H}_4\text{O}_5 \cdot 5\text{H}_2\text{O}$ (Malate) (136); *P*

λ	α	β	γ
431G	1.483	1.509	
486F	1.479	1.502	1.508
589D	1.473	1.497	1.501
656C	1.470	1.494	1.498

126. Mg_2SiO_4 , Forsterite (olivine) (133); *P*; for other olivines, see 131, 154

λ	α	β	γ
431G	1.6492+	1.6645+	1.6829
436Hg	1.6486	1.6639	1.6822
486F	1.6431	1.6582	1.6764
546Hg	1.6385	1.6534	1.6715
578Hg	1.6365	1.6513+	1.6694+
589D	1.6359	1.6507	1.6688
656C	1.6329	1.6475	1.6655
668He	1.6324+	1.6470	1.6650

2*V_C* = 84.9°; 2*V_G* = 85.7°.127. $\text{MgSiF}_6 \cdot 6\text{H}_2\text{O}$ (200)

λ	ω	ϵ
486F	1.3473	1.3634
589D	1.3439	1.3602
656C	1.3427	1.3587

129. $2(\text{Pb}, \text{Mg})\text{O} \cdot \text{SiO}_2 \cdot \text{H}_2\text{O}$ ca., Molybdophyllite (69)129.1. $\text{MgTi}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2129.2. $\text{MgTi}_2(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2130. $\text{MgPt}(\text{CN})_4 \cdot 7\text{H}_2\text{O}$ (73)

λ	ω	ϵ
589D	1.561	1.91
656C	1.558	1.905
687B	1.555	

131. $2(\text{Mg}, \text{Fe})\text{O} \cdot \text{SiO}_2$, Chrysolite or olivine (64.1); cf. 126

λ	$\delta\beta_D$	λ	$\delta\beta_D$
410h	200	589D	0
431G	161	656C	-35+
486F	86	719a	-61
527E	46	761A	-75

Samples averaged 16 wt. % ($\text{FeO} + \text{Fe}_2\text{O}_3 + \text{MnO}$). $\alpha_D = 1.665$; $\beta_D - \alpha_D = 0.0186$; $\gamma_D - \beta_D = 0.0189$. $\delta\alpha_D = 0.94\delta\beta_D$; $\delta\gamma_D = 1.02\delta\beta_D$. 2*V_G* = 88° 34'; 2*V_C* = 90° 1'.132. $\text{MgCrO}_4 \cdot 7\text{H}_2\text{O}$ (200)

λ	α	β	γ
589D	1.521	1.550	1.568
656C	1.513	1.541	1.563

133. $\text{Mg}(\text{NH}_4)_2(\text{CrO}_4) \cdot 6\text{H}_2\text{O}$ (133, 220); see Table 2134. $\text{Mg} \cdot \text{B}_{16}\text{O}_{30}\text{Cl}_2$ (?), Boracite (118)Isotropic if $t \geq 290^\circ\text{C}$; at 290° , $n_D = 1.671$, $n_{502} - n_{588} = 0.0060$; $\tau = +1.0$ if $290^\circ < t < 650^\circ\text{C}$. Just below inversion point (ca. 290°) n exceeds above values by 0.004 ca.135. $\text{Mg}_3\text{Al}_2\text{H}_8\text{Si}_3\text{O}_{18}$ ca., Penninite (98, 157)

λ	$\delta\beta_D$	λ	$\delta\beta_D$
486F	78	589D	0
535Tl	35	671Li	-37

 $\alpha_D = \beta_D = \gamma_D = 1.58$.

136. $3\text{MgO} \cdot \text{FeO} \cdot 4\text{Al}_2\text{O}_3 \cdot 10\text{-SiO}_2 \cdot \text{H}_2\text{O}$ *ca.*, Cordierite (145)

λ	α	β	γ
589D	$\begin{cases} 1.533 & 1.537 & 1.541 \\ 1.552 & 1.556 & 1.561 \end{cases}$		
λ	$\delta\beta_D$	λ	$\delta\beta_D$
393K	171	486F	62+
410h	145	656C	-26+
434G'	113	760A	-56

$\delta\alpha_D$, $\delta\beta_D$, $\delta\gamma_D$ are alike; variations of $\pm 5\%$. For $20^\circ < t < 320^\circ$, $\tau_\alpha = \tau_\beta = \tau_\gamma = 1.3$, same for all λ 's (143); *cf.* (145). For effects of radiation from Po, *see* (92).

137. Mg-tourmaline; *see* 225

137.1. CaSO_4 , Anhydrite (61, 103, 115, 139); *P*

λ	α	β	γ
589D	$\begin{cases} 1.5693 & 1.5752 & 1.6130 \\ 1.5698 & 1.5757 & 1.6139 \end{cases}$		
λ	$\delta\beta_D$	λ	$\delta\beta_D$
431G	103	687B	-31
486F	55	619a	-39+
656C	-22+		

$\delta\alpha = 0.97\delta\beta$; $\delta\gamma = 1.11\delta\beta$.

λ	τ_α	τ_β	τ_γ
	$-50^\circ < t < 205^\circ$		
431	-0.3	-0.6	-1.0
687	-0.4	-0.6	-1.0
	$205^\circ < t < 560^\circ$		
431	-0.5+	-0.5+	-1.4
687	-0.5	-0.7	-1.4+

138. $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, Gypsum (47, 97, 107); *P*

λ	α	β	γ
589D	$\begin{cases} 1.5195 & 1.5216 & 1.5283 \\ 1.5208 & 1.5230 & 1.5305 \end{cases}$		
λ	$\delta\beta_D$	λ	$\delta\beta_D$
434G'	98	687B	-34
486F	54+	760A	-54
656C	-24		

$\delta\alpha_D = 0.99\delta\beta_D$; $\delta\gamma_D = 1.03 \times \delta\beta_D$. At 20°C , $+2V_D = 60^\circ$ *ca.*, $2V_C = 2V_D - 24'$ to $-28'$, $2V_F = 2V_D - 31'$ to $-43'$. If $12^\circ < t < 90^\circ$, $\tau_\alpha = -1.1$, $\tau_\beta = -4.2$, $\tau_\gamma = -2.4$ for blue; and $\tau_\alpha = -1.5$, $\tau_\beta = -4.5$, $\tau_\gamma = -2.8$ for red. Becomes uniaxial near 90°C .

139. $\text{CaS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$ (167); *cf.* (17); *p*

λ	ω	ϵ
436Hg	1.5649	1.5516
492Hg	1.5580	1.5467
546Hg	1.5541	1.5431
589D	1.5516	1.5414
623Hg	1.5498	1.5399

140. $3\text{Ca}_3\text{P}_2\text{O}_8 \cdot \text{Ca}(\text{F}, \text{Cl})_2$ *ca.*, Apatite (13, 29, 226, 247, 249)

λ	$\delta\omega_D$	λ	$\delta\omega_D$
	(59)		(59)
405Hg	171+	546Hg	25
434G	127+	656C	-29
486F	71	706He	-46

With 589D; $\omega = 1.633$ to 1.667, $\epsilon_D = \omega_D - (0.001$ to $0.004+)$. $\delta\epsilon_D = 0.96\delta\omega_D$ to $0.98\delta\omega_D$, range (13, 63, 85, 228) of $\delta\omega_D$ and $\delta\epsilon_D = \pm 4\%$ from tabulated values. For $0^\circ < t < 600^\circ\text{C}$ (63) $\tau_\omega = -0.25$, $\tau_\epsilon = -0.54$ for $\lambda = 471$; and $\tau_\omega = -0.35$, $\tau_\epsilon = -0.64$ for $\lambda = 706$. Discontinuity (?) in ω and ϵ at $t = -50^\circ\text{C}$.

141. CaCO_3 , Aragonite (171); *P*

λ	α	β	γ
397H	1.5422+	1.7051	1.7101
431G	1.5388	1.6983+	1.7032
486F	1.5348	1.6905+	1.6951+
527E	1.5326+	1.6863+	1.6908+
589D	1.5301+	1.6815+	1.6859
656C	1.5282	1.6778	1.6820+
687B	1.5275	1.6763	1.6806

Indices for *D* vary ± 0.0003 *ca.* (44, 115, 118, 143, 182). Slow irreversible change at 320° .

λ	τ_α	τ_β	τ_γ	Lit.
	$0^\circ < t < 300^\circ$			
471	-1.2	-2.5	-2.9	(118)
480	-1.3+	-2.5	-2.7+	(143)
671	-1.4	-2.5+	-2.8	(143)
706	-1.1	-2.7	-3.0	(118)

142. CaCO_3 , Calcite, Iceland spar (33, 37, 75, 83, 119, 173); *P*; *cf.* Fig. 1; for X-rays, $\text{MoK}\alpha_1$, $\lambda = 0.070772$, $\omega = \epsilon(?) = 0.9999980$ (83)

λ^*	ω_{18}°	ϵ_{18}°
198.98Al		1.57814
200.06Au	1.90302	1.57663
204.448Au	1.88263	1.57098
208.20Au	1.86743	1.56654
211.07Au	1.85695	1.56340
214.439Cd	1.84574	1.55959
219.462Cd	1.83086	1.55511
223.986Cd	1.81903	1.55117
226.503Cd	1.81300	1.54914
228.803Cd	1.80778	1.54736
230.663Cd	1.80377	1.54596
231.288Cd	1.80246	1.54551
232.115Cd	1.80075	1.54491
242.796Au	1.78121	1.53783
257.304Cd	1.76048	1.53013
274.867Cd	1.74147	1.52267
291.358Au	1.72776	1.51728+
298.062Cd	1.72304	1.51511
303.412Sn	1.71956	1.51366
312.923Cd	1.71393	1.51128+
330.28Zn	1.70516	1.50752
340.365Cd	1.70080	1.50561
361.25Cd	1.69314	1.50223
394.402Al	1.68374	1.49803
396.154Al	1.68331	1.49782+
396.848CaH	1.68314	1.49775
404.656Hg	1.68134	1.49694
410.174H ₂ h	1.68014	1.49639

142.—(Continued)

λ^*	ω_{18}°	ϵ_{18}°
430.78+G	1.67610+	1.49454+
434.047H ₂ G'	1.67552+	1.49428
435.834Hg	1.67520	1.49414
447.148He	1.67331+	1.49327+
471.315He	1.66976+	1.49164
486.133H ₂ F	1.66785	1.49076
491.60Hg	1.66719	1.49045
492.193He	1.66711+	1.49042
501.568He	1.66604+	1.48992+
526.995Fe		
527.01E	1.66341+	1.48873+
535.047Ti	1.66267	1.48838
546.072Hg	1.66168+	1.48792+
576.960Hg	1.65921+	1.48651
579.066Hg	1.65906+	1.48674
587.563He	1.65846+	1.48647
589.29NaD	1.65836+	1.48641+
643.847Cd	1.65503+	1.48491
656.275H ₂ C	1.65438	1.48461+
667.815He	1.65381+	1.48436+
670.786Li	1.65367	1.48430
687.2B	1.65290+	1.48396
706.520He	1.65207	1.48359
718.9a	1.65156+	1.48337+
760.7A	1.65000	1.48269+
768.19K ₂ A'	1.64974	1.48258
800.7	1.64867	1.48212
904.7	1.64579	1.48095
1041.7	1.64276	1.47982
1159.2	1.64052	1.47907
1307.0	1.63790	1.47828
1497.2	1.63459+	1.47741+
1614.6		1.47692
1681.5	1.63126	
1847.8	1.62802+	
1908.5		1.47570
1945.7	1.62603	
2053.1	1.62371	
2099.8		1.47489
2171.9	1.62099	
2324.3		1.47389
640a	0.76	
650a	0.13	
660a	0.07	
680a	0.11	
690a	0.34	(120.1)
695a	0.35	
700a	0.36	
705a	0.67	
710a	2.9	

$t = 61.5^\circ\text{C}$ (134, 161); *cf.* (147)

λ	τ_ω^\dagger	τ_ϵ^\dagger
211.07	2.2	
214.44	2.02	2.62
219.46	1.82	2.45
226.50		2.29
231.29	1.42	2.21
257.30	0.95	1.89
274.87	0.76	1.76
298.0	0.60	1.64
312.9	0.53	
340.36	0.44	1.49
361.25	0.40	1.43
396.85H	0.33	1.36
434.05G'	0.30	1.32
486.13F	0.25	1.27
589.29D	0.21	1.21
589.29D	0.21§	1.19§
656.28C	0.19	1.18
t	$\tau_{\omega D}^\parallel$	$\tau_{\epsilon D}^\parallel$
18	0.071¶	1.05¶
57.1	0.078	1.094
61.5	0.079¶	1.10¶

142.—(Continued)

t	$\tau_{\omega D}^\parallel$	$\tau_{\epsilon D}^\parallel$
152.5	0.100	1.185
248.5	0.132	1.313
349.0	0.168	1.435

* In air at 15°C and 760 mm of Hg (101.1).
† All values on smooth curve.
‡ In air.
§ At 18° ; calculated (134, 161).
¶ In vacuum (161).
¶ From curve.

143. $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ (Oxalate) (Whewellite) (100); *p*

λ	α	β	γ
535Ti	1.4939	1.5599	1.6567
589D	1.4909	1.5554	1.6502
671Li	1.4878	1.5513	1.6450

144. $\text{Ca}(\text{CHO}_2)_2$ (Formate) (178)

λ	α	β	γ
527E <i>ca.</i>	1.5132	1.5167	1.5819
589D	1.5101	1.5135	1.5775
687B <i>ca.</i>	1.5067	1.5100	1.5731

145. $\text{CaH}_2(\text{C}_4\text{H}_4\text{O}_5)_2 \cdot 6\text{H}_2\text{O}$ (Acid malate) (178)

λ	α	β	γ
527E <i>ca.</i>	1.4972	1.5112	1.5492
589D	1.4933	1.5073	1.5449
687B <i>ca.</i>	1.4887	1.5029	1.5404

146. CaSiO_3 (65); *P* (high-temperature form)

λ	α	β	γ
486F	1.618	1.618	1.663
589D	1.610	1.610	1.654
656C	1.607	1.607	1.649

147. $\text{Ca}_3\text{Si}_2\text{O}_7 \cdot 3\text{H}_2\text{O}$, Afwillite (147.1); *P*

λ	α	β	γ
546Hg	1.620	1.623+	1.636+
589D	1.617	1.620+	1.633+
668He	1.615	1.618	1.631

148. CaTiSiO_5 *ca.*, Titanite, sphene; *cf.* Fig. 1; zoned specimens (82)

λ	α	β	γ
589D	1.880	1.888	2.007
λ	$\delta\alpha_D$	$\delta\beta_D$	$\delta\gamma_D$
460 <i>ca.</i>	322	283	532
486F <i>ca.</i>	232	203	377
656C <i>ca.</i>	-81	-73	-136
719a <i>ca.</i>	-146	-126	-228

For purest specimens, $\alpha_D = 1.88(1.91)$, $\gamma_D = 1.98(2.05)$, $\beta_D = \alpha_D + 0.002(8) = \gamma_D - 0.08(13)$; $+2V_D = 24^\circ(32^\circ)$; $2V_C = 2V_F + 10^\circ$ *ca.* (33, 82).

149. $\text{PbCa}_2(\text{C}_3\text{H}_5\text{O}_2)_6$ (Propionate) (71)

λ	ω	ϵ
535Ti	1.5310	1.5436
589D	1.5268	1.5389
671Li	1.5231	1.5341

150. $2\text{CaO} \cdot \text{ZnO} \cdot 2\text{SiO}_2$, Hardy-stonite (⁹³); specimen was 94 % $2\text{CaO} \cdot \text{ZnO} \cdot 2\text{SiO}_2$

λ	ω	ϵ
410h <i>ca.</i>	1.6941	1.6810
434G' <i>ca.</i>	1.6893	1.6766
486F <i>ca.</i>	1.6815	1.6696
589D <i>ca.</i>	1.6720	1.6606
656C' <i>ca.</i>	1.6681	1.6570
719a <i>ca.</i>	1.6653	1.6544

151. $\text{CaPt}(\text{CN})_4 \cdot 5\text{H}_2\text{O}$ (¹²); *p*; see Fig. 2

λ	α	β	γ
486F	1.6361		
492He			1.994
502He	1.6336	1.6550	1.949+
588He	1.6228	1.6444	1.767
688He	1.6169	1.6383	1.708
706He			1.691+

152. $\text{Ca}_2\text{Fe}(\text{CN})_6 \cdot 12\text{H}_2\text{O}$ (⁵⁰); *p*

λ	α	β	γ
535Tl	1.5753	1.5871	1.6017
589D	1.5700	1.5818	1.5961
671Li	1.5646	1.5764	1.5902

153. $\text{CaFeSi}_2\text{O}_6$, Hedenbergite (²³⁷)

154. $5\text{Fe}_2\text{SiO}_4 \cdot 4\text{Ca}_2\text{SiO}_4$, Olivine (or iron-monticellite) (⁹³); *cf.* 126; specimen was 92 % $5\text{Fe}_2\text{SiO}_4 \cdot 4\text{Ca}_2\text{SiO}_4$

λ	α	β	γ
410h	1.7200	1.7628	1.7711
434G'	1.7146	1.7562	1.7648
486F	1.7062	1.7460	1.7547
589D	1.6958	1.7340	1.7430
656C	1.6913	1.7291	1.7383
719a	1.6884	1.7256	1.7351

155. CaMoO_4 (²⁴⁵); *p*; *cf.* Fig. 1

λ	ω	ϵ
535Tl	1.981	1.992
589D	1.970	1.980
671Li	1.958	1.966

Specimen containing

$\text{Yt}_2(\text{MoO}_4)_3$

λ	ω	ϵ
535Tl	2.002	2.011
589D	1.989	1.998
671Li	1.977	1.985

Specimen containing 24.7 %

$\text{Yt}_2(\text{MoO}_4)_3$ and 21 %

$\text{Ce}_2(\text{MoO}_4)_3$

λ	ω	ϵ
535Tl	2.014	2.019
589D	2.000+	2.005
671Li	1.989	1.992

156. CaWO_4 , Scheelite (²⁴⁵); *P*; pure CaWO_4

λ	ω	ϵ
535Tl	1.928+	1.945
589D	1.920	1.936+
671Li	1.911	1.927

Addition of 10.3 % $\text{Ce}_2(\text{WO}_4)_3$ increases ω by 0.006+ and ϵ by 0.004+.

157. $2\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$, Colemanite (¹³⁹); *cf.* (²²⁷)

λ	α	β	γ
486F	1.5921	1.5981	1.6204
589D	1.5863	1.5920	1.6140
656C	1.5835	1.5892	1.6110
687B	1.5823	1.5881	1.6098

158. $\text{CaB}_2\text{Si}_2\text{O}_8$, Danburite* (^{89.1})

λ	α	β	γ
535Tl	1.6339	1.6366	1.6393
589D	1.6309	1.6337	1.6363
671Li	1.6273	1.6303	1.6331

* Data for α recalculated.

159. $\text{CaAl}_2\text{Si}_2\text{O}_8$, Anorthite; *P*; for other feldspars, *v.* 261

λ	α	β	γ
589D	1.576*	1.584*	1.589*

For specimen of 3.9M % albite

λ	α	β	γ
486F	1.5807	1.5888	1.5947
535Tl	1.5770	1.5851	1.5906
589D	1.5738	1.5818	1.5872
671Li	1.5702	1.5787	1.5834
687B	1.5697	1.5783	1.5828

$\lambda \dots 486 \quad 535 \quad 589 \quad 671$
 $-2V. \quad 78^\circ + 77^\circ + 77^\circ \quad 76^\circ +$

* By extrapolation from impure specimens, and for synthetic material (¹²³, ²³⁶⁻¹).

160. $(\text{CaAl}_2\text{Si}_2\text{O}_8)_y + (\text{NaAlSi}_3\text{O}_8)_x$, Feldspars; see 229

161. $\text{Ca}_2\text{Al}_3\text{HSi}_3\text{O}_{13}$, Clinzoisite (epidote) (⁷⁷, ¹⁸⁵, ²⁴⁴); for Fe-epidote, see 163

λ	α	β	γ
589D	1.714	1.717	1.719

λ	$\delta\beta_D$
486F <i>ca.</i>	90
527E <i>ca.</i>	50
656C <i>ca.</i>	-40

Approximately $\delta\alpha_D = \delta\beta_D = \delta\gamma_D$.

162. $\text{Ca}_4\text{Al}_6\text{Si}_6\text{O}_{25}(\text{CO}_3)$ *ca.*, Meionite (²², ²⁸, ⁸⁸, ^{117.1}, ²³⁷)

λ	$\delta\omega_D$
486F	71
535Tl	31
656C	-30
671Li	-35
700	-45

With 589D, $\omega = 1.61+$, $\epsilon = \omega - 0.046$. $\delta\epsilon_D = 0.89\delta\omega_D$. Same values except of birefringence (?), for specimens containing SO_4 . Scapolite is intermediate between Meionite and Marialite (²²¹).

163. $\text{Ca}_2(\text{Al}, \text{Fe})_3\text{HSi}_3\text{O}_{13}$, Epidote (⁷⁷); specimen contains 37 atoms Fe to 63 atoms Al

λ	α	β	γ
589D	1.729	1.763	1.780

163.—(Continued)

Approximately $\delta\alpha_D = \delta\beta_D = \delta\gamma_D$ and probably increases with increase of Fe/Al, as do the refractivity and birefringence; *cf.* 161.

164. $\text{Ce}(\text{La}, \text{etc.})(\text{CO}_3)_3 \cdot \text{CaF}_2$ *ca.* Parisite (¹⁵⁸)

λ	ω	ϵ
453	1.684	1.788
533	1.676	1.775+
535Tl	1.6767*	1.7729*
589D	1.672	1.770
589D	1.6742*	1.7701*
667	1.668+	1.764+
671Li	1.6718*	1.7664*

* From (⁷⁰).

165. $\text{Ca}_3(\text{Ce}, \text{La}, \text{Nd}, \text{Pr})_4\text{Si}_3\text{O}_{15}$, Beckelite (¹¹⁰)

166. $2\text{CaO} \cdot 5\text{MgO} \cdot \text{Al}_2\text{O}_3 \cdot \text{F}_2 \cdot 7\text{SiO}_2$ *ca.*, Hornblende (¹⁰⁹); see also 171

λ	α	β	γ
589D	1.614	1.618	1.633
535Tl	$(\delta\alpha = \delta\beta)_{671} = 62,$ $\delta\gamma_{671} = 63$		

167. $\text{Ca}_3\text{Mg}_3\text{O}_2\text{F}_8$ *ca.*, Nocerine (²⁴²)

λ	ω	ϵ
475	1.5138	1.4895
533	1.5111	1.4873
589D	1.5091	1.4856
633	1.5076	1.4848

168. $\text{CaMg}(\text{CO}_3)_2$, Dolomite (¹⁰⁴) curves; *P*

λ	ω	ϵ	% FeCO
434G'	1.6964	1.5091	0
486F	1.6893	1.5056	0
	1.6842	1.5032	0
535Tl	+13*	+10*	
	+122†	+83†	9.4
	+167†	+107†	11.9
	1.6799	1.5013	0
589D	+14*	+9*	
	+121†	+82†	9.4
	+165†	+105†	11.9
656C	1.6760	1.4995	0
	1.6753	1.4992	0
671Li	+14*	+10*	
	+118†	+83†	9.4
	+161†	+104†	11.9
768A'	1.6714	1.4974	

* Data (⁹⁶) minus data (¹⁰⁴).

† Data (²³) minus data (¹⁰⁴).

169. $\text{CaMgSi}_2\text{O}_6$, Diopside, (pyroxene) (¹²⁸, ¹³³); *P*

λ	α	β	δ
589D	1.664(6)	1.671(3)	1.694(5)
λ	$\delta\beta_D$	λ	$\delta\beta_D$
405Hg	187	535Tl	34+
434G'	140	656C	-32+
486F'	77+	768A'	-71

169.—(Continued)

$\delta\alpha_D = \delta\beta_D$; $\delta\gamma_D = 1.055\delta\beta_D$. For specimens with *ca.* 4.7 % Fe_2O_3 and 5.1 % FeO, (augite) all δ 's are 25% > δ 's for diopside (⁹⁸, ²³⁸).

170. $2\text{CaO} \cdot \text{MgO} \cdot 2\text{SiO}_2$, Åkermanite (⁹³); specimen has 95 % $2\text{CaO} \cdot \text{MgO} \cdot 2\text{SiO}_2$

λ	ω	ϵ
410h	1.6591	1.6623
434G'	1.6552	1.6585
486F	1.6478	1.6514
589D	1.6392	1.6431
656C	1.6355	1.6397
719a	1.6332	1.6374

For Melilite, see (35, 90).

171. $2\text{CaO} \cdot 5\text{MgO} \cdot \text{H}_2\text{O} \cdot 8\text{SiO}_2$ *ca.*, Tremolite (¹⁰⁹)

λ	α	β	γ
589D	1.600	1.614	1.625
535Tl	$(\delta\alpha = \delta\beta)_{671} = 56,$ $\delta\gamma_{671} = 65$		

172. $\text{Sr}(\text{ClO}_3)_2$ (¹⁶⁵)

λ	α	β	γ
486F	1.5717	1.6116	1.6337
589D	1.5670	1.6047	1.6257
687B	1.5636	1.6002	1.6210

173. SrSO_4 , Celestite (¹⁰³, ¹¹⁵); *P*

λ	α	β	γ
589D	1.6214	1.6214	1.6305
	1.6220	1.6245	1.6309

δ 's are 9 % less than for barite (¹⁷⁸) (⁶, ¹⁰³). For red and $-50^\circ < t < +200^\circ$, $\tau_\alpha = \tau_\gamma = -1.6$, $\tau_\beta = -1.3$; $200^\circ < t < 500^\circ$, $\tau_\alpha = -1.7$, $\tau_\beta = -1.6$, $\tau_\gamma = -2.2$. For blue, τ 's about 10 % less (⁶, ¹⁰³).

174. $\text{SrS}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$ (¹⁶⁷); *cf.* (¹⁷); *P*

λ	ω	ϵ
405Hg	1.5461	1.5391
436Hg	1.5417	1.5357
486F'	1.5362	1.5315
492Hg	1.5357	1.5310
546Hg	1.5316	1.5278
579Hg	1.5297	1.5262
623Hg	1.5277	1.5246
656C	1.5263	1.5235
691Hg	1.5253	1.5226

175. $\text{Sr}(\text{CHO}_2)_2$ (Formate) (¹⁵⁴); *cf.* (¹⁷⁸); *p*

λ	α	β	γ
535Tl	1.560	1.580	1.605
589D	1.559	1.574	1.598
671Li	1.555	1.571	1.594

175.1. $\text{Sr}(\text{CHO}_2)_2 \cdot 2\text{H}_2\text{O}$ (Formate) (¹⁷⁸); *p*

λ	α	β	γ
527E <i>ca.</i>	1.4869	1.5244	1.5420
589D	1.4838	1.5210	1.5382
687B <i>ca.</i>	1.4806	1.5174	1.5342

176. SrSiO_3 (65); *P*

λ	α	β	γ
486F	1.606	1.606	1.646
589D	1.599	1.599	1.637
656C	1.596	1.596	1.634

177. Sr_2SiO_4 (65); *P*

λ	α	β	γ
486F	1.740	1.744	1.766
589D	1.727	1.732	1.756
656C	1.722	1.727	1.752

178. $\text{SrPt}(\text{CN})_4 \cdot 5\text{H}_2\text{O}$ (15)

179. SrMoO_4 (245); *P*; cf. Fig. 1

λ	ω	ϵ
535Tl	1.926	1.932
589D	1.917	1.922
671Li	1.906	1.910

180. $\text{Ca}_2\text{Sr}(\text{C}_3\text{H}_3\text{O}_2)_6$ (Propionate) (71); *p*

λ	ω	ϵ
535Tl	1.4897	1.4987
589D	1.4871	1.4956
671Li	1.4839	1.4917

181. $\text{BaBr}_2 \cdot 2\text{H}_2\text{O}$ (54); *P*

λ	α	β	γ
486F	1.7282	1.7418	1.7588
535Tl	1.7197	1.7334	1.7507
589D	1.7129	1.7266	1.7441
656C	1.7067	1.7205	1.7382
671Li	1.7056	1.7194	1.7371

182. BaSO_4 , Barite (56, 61, 85, 103, 115); *P*

λ	α	β	γ
589D	1.6360	1.6372	1.6480
	1.6368	1.6379	1.6486
λ	$\delta\alpha_D^*$	$\delta\beta_D^*$	$\delta\gamma_D^*$
397H	167+	170	176
431G	120+	122	126+
486F	64	65+	68
656C	-26	-26+	-27+
716a	-45	-46	-47
λ	$\tau\alpha$	$\tau\beta$	$\tau\gamma$
$-50^\circ < t < +215^\circ$ (103)			
431	-1.7+	-1.4+	-2.3
686	-1.8	-1.6	-2.3
$215^\circ < t < 560^\circ$ (103)			
431	-2.0+	-1.8	-2.6
686	-2.1	-1.8	-2.6
$0^\circ < t < 300^\circ$ (143)			
480	-2.0	-1.7+	-2.5+
671	-2.0+	-1.8+	-2.6

* From (85, 103, 139, 143).

183. $\text{Ba}(\text{CHO}_2)_2$, (Formate) (178); *p*

λ	α	β	γ
527E ca.	1.578	1.602	1.641
589D	1.573	1.597	1.636
687B ca.	1.568	1.592	1.631

184. BaSiO_3 (65); *P*; cf. Fig. 1

λ	α	β	γ
486F	1.682	1.684	1.688
589D	1.673	1.674	1.678
656C	1.669	1.670	1.673

185. BaSi_2O_4 (65); *P*

λ	α	β	γ
486F	1.602	1.617	1.632
589D	1.597	1.612	1.621
656C	1.595	1.610	1.618

186. $\text{Ba}_2\text{Si}_3\text{O}_8$ (65); *P*

λ	α	β	γ
486F	1.627	1.632	1.652
589D	1.620	1.625	1.645
656C	1.617	1.622	1.641

187. $\text{BaPt}(\text{CN})_4 \cdot 4\text{H}_2\text{O}$ (12); see Fig. 2

187.1. $\text{BaBe}_2\text{Si}_2\text{O}_7$, Barylite (248); *p*

λ	α	β	γ
540	1.699	1.705	1.707
589D	1.691	1.696	1.703
656C	1.687	1.692	1.699

188. $\text{BaCa}_2\text{Si}_3\text{O}_9$ (65); *P*

λ	ω	ϵ
486F	1.690	1.678
589D	1.681	1.668
656C	1.677	1.664

189. $\text{Li}_2\text{S}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$ (200)

λ	α	β	γ
486F	1.5548	1.5680	1.5887
589D	1.5487	1.5602	1.5788
656C	1.5462	1.5565	1.5763

190. $\text{Li}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2$, Spodumene (57)

λ	α	β	γ
589D	1.660	1.665	1.675
λ	$\delta\beta_D$		
535Tl	31		
671Li	-35		
$\delta\alpha_D = \delta\beta_D$; $\delta\gamma_D = 1.06\delta\beta_D$.			

191. $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ (46); *P*

λ	α	β	γ
535Tl	1.4919	1.5117	1.5405
589D	1.4886	1.5079	1.5360
671Li	1.4849	1.5038	1.5311

191.1. NaNO_3 , Soda niter (133); *P*

λ	ω	ϵ
434G'	1.6126	1.3404
436Hg	1.6121	1.3403
486F	1.5998	1.3384
501He	1.5968	1.3379
546Hg	1.5899	1.3365
578Hg	1.5860	1.3363
589D	1.5848*	1.3360*
656C	1.5791	1.3347
668He	1.5783	1.3345

* Cf. 102.1, 177).

192. $\text{Na}_4\text{P}_2\text{O}_7 \cdot 10\text{H}_2\text{O}$ (45); *p*

λ	α	β	γ
535Tl	1.4526	1.4551	1.4629
589D	1.4499	1.4525	1.4604
671Li	1.4470	1.4496	1.4575

193. $\text{NaHPO}_3 \cdot 3\text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.4883	1.4927	1.5074
589D	1.4855	1.4897	1.5041
671Li	1.4822	1.4861	1.5006

194. $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.4583	1.4881	1.4902
589D	1.4557	1.4852	1.4873
671Li	1.4527	1.4821	1.4841

195. $\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.4123	1.4655	1.4843
589D	1.4400+	1.4629	1.4814+
671Li	1.4376	1.4600	1.4782

196. $\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.4437	1.4449	1.4552
589D	1.4411+	1.4424	1.4526
671Li	1.4382	1.4395	1.4497

197. $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$ (45, 46); *P*

λ	α	β	γ
535Tl	1.4348	1.4389	1.4402
589D	1.4321	1.4361	1.4373
671Li	1.4290	1.4330	1.4341

198. $\text{Na}_2\text{H}_2\text{P}_2\text{O}_7 \cdot 6\text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.4623	1.4672	1.4677
589D	1.4599	1.4645	1.4649
671Li	1.4573	1.4616	1.4617

199. $\text{Na}_3\text{HP}_2\text{O}_6 \cdot 9\text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.4682	1.4769	1.4836
589D	1.4653	1.4738	1.4804
671Li	1.4622	1.4705	1.4769

200. $\text{Na}_3\text{AsO}_4 \cdot 12\text{H}_2\text{O}$ (10); *P*

λ	ω	ϵ
535Tl	1.4624	1.4704
589D	1.4589	1.4669
671Li	1.4553	1.4630

201. $\text{NaH}_2\text{AsO}_4 \cdot \text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.5418	1.5573	1.5647
589D	1.5382	1.5535	1.5607
671Li	1.5341	1.5494	1.5563

202. $\text{Na}_2\text{HAsO}_4 \cdot 7\text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.4654	1.4689	1.4814
589D	1.4622	1.4658	1.4782
671Li	1.4587	1.4623	1.4746

203. $\text{Na}_2\text{HAsO}_4 \cdot 12\text{H}_2\text{O}$ (45); *P*

λ	α	β	γ
535Tl	1.4482	1.4527	1.4545
589D	1.4453	1.4495+	1.4513
671Li	1.4420	1.4462	1.4480

204. $\text{NaSO}_3 \cdot \text{NH}_2\text{C}_6\text{H}_4 \cdot 2\text{H}_2\text{O}$ (Sulfanilate) (52); *P*

λ	α	β	γ
535Tl	1.5411	1.5722	1.6573
589D	1.5362	1.5667	1.6490
671Li	1.5312	1.5611	1.6405

205. $\text{NaSO}_3 \cdot \text{C}_{10}\text{H}_6\text{NH}_2 \cdot 4\text{H}_2\text{O}$ (Naphthionate) (52); *P*

λ	α	β	γ
535Tl	1.5800	1.6067	1.6657
589D	1.5731	1.5987	1.6570
671Li	1.5660	1.5906	1.6460

205.1. $(\text{NH}_4)\text{NaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ (Tartrate*) (8.1 81.1); *P*

λ	α	β	γ
436	1.504+	1.507+	1.508
546	1.497+	1.500+	1.501+
589D	1.495+	1.498+	1.499+
650	1.494	1.497	1.498

* Mixed crystals of this with the K-Na salt (8.1).

206. Na_2SiF_6 (160); *P*; cf. Fig. 1

λ	ω	ϵ
434G'	1.3153	1.3118
486F	1.3141	1.3106
589D	1.3125	1.3089
656C	1.3116	1.3081

207. $\text{Na}_2\text{O} \cdot \text{ZrO}_2 \cdot 6\text{SiO}_2 \cdot 3\text{H}_2\text{O}$, Elpidite (70)

λ	α	β	γ
535Tl	1.5632	1.5674	1.577
671Li	1.5575	1.5620	1.570

207.1. $\text{Na}_2(\text{Ti}, \text{Zr})\text{O}_2 \cdot \text{SiO}_2$, Lorenzenite (70)

λ	α	β	γ
535Tl	1.758		1.802
589D	1.743	1.748	1.788
671Li	1.732		1.778

+2E_D = 72°; 2V_D = 39°

208. $\text{Na}_2\text{Pt}(\text{CN})_4 \cdot 3\text{H}_2\text{O}$ (15)

209. $\text{Na}_2\text{Fe}_2\text{Si}_4\text{O}_{12}$, Acmite (132); *P*

λ	α	β	γ
589D	1.77+	1.82	1.83+

Dispersion 6% greater than for the following, *p*:

434G'	1.8017	1.8544	1.877
436Hg	1.8000	1.8524	
486F	1.7853	1.8304	1.850+
502He	1.7818	1.8254	
546Hg	1.7736	1.8142+	
589D	1.7675	1.8062	1.823
656C	1.7608	1.7974	1.813
668He	1.7597	1.7961	

210. $\text{Na}_6\text{FeTi}_2\text{Si}_{12}\text{O}_{22}\text{F}$, Narsarsukite (70)

211. $\text{Na}_2\text{CrO}_4 \cdot 4\text{H}_2\text{O}$ (?) (40)

212. $\text{Na}_2\text{O} \cdot \text{P}_2\text{O}_5 \cdot (\text{MoO}_3)_5 \cdot 14\text{H}_2\text{O}$ (50); *P*

λ	α	β	γ
535Tl	1.6017	1.6494	1.6610
589D	1.5962	1.6411	1.6520
671Li	1.5906	1.6328	1.6430

213. $\text{Na}_3\text{VO}_4 \cdot 10\text{H}_2\text{O}$ (10); *P*

λ	ω	ϵ
535Tl	1.5460	1.5537
589D	1.5398	1.5475
671Li	1.5332	1.5408

214. $\text{Na}_3\text{VO}_4 \cdot 12\text{H}_2\text{O}$ (10); *P*

λ	ω	ϵ
535Tl	1.5150	1.5293
589D	1.5095	1.5232
671Li	1.5040	1.5173

215. $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$, Borax (46); P

λ^*	α	β	γ
589D	1.4463	1.4682	1.4712
	1.4468	1.4694	1.4724
λ	$\delta\beta_D$		
486F	56		
535Tl	25		
671Li	-29		
$\delta\alpha_D = 0.89\delta\beta_D$; $\delta\gamma_D = 0.97 \times \delta\beta_D$. $2V_D = 39^\circ 14'$ to $39^\circ 36'$.			
* From (115).			

216. $\text{Na}_2\text{O} \cdot 2\text{Al}_2\text{O}_3 \cdot \text{Sb}_2\text{O}_5$, Swedenborgite (2)

λ	ω	ϵ
486F	1.7822	1.7791
527E	1.7775	1.7748
589D	1.7724	1.7700
656C	1.7696	1.7668
687B	1.7684	1.7658

217. NaAlSiO_4 *ca.*, Nephelite

λ	ω	ϵ	Lit.
486F <i>ca.</i>	1.5480	1.5443	(189)
589D	1.5417	1.5382	(189)
589D	1.537*	1.533*	(24)
589D	1.537†	1.539†	(24)
656C <i>ca.</i>	1.5392	1.5357	(189)
759A <i>ca.</i>	1.5366	1.5332	(189)

* Pure NaAlSiO_4 .† Contains 35% $\text{CaAl}_2\text{Si}_2\text{O}_8$.218. $\text{NaAlSi}_3\text{O}_8$, Albite; feldspar, *cf.* 261 (67, 106, 133); P

λ	α	β	γ
589D	1.5282	1.5323	1.5386
λ	$\delta\beta_D$	λ	$\delta\beta_D$
405Hg	138-	656C	-24+
434G'	104-	687B	-34
486F	58	706He	-39+
535Tl	27-	768A'	-54+

 $\delta\alpha_D = 0.985\delta\beta_D$; $\delta\gamma_D = 1.02 \times \delta\beta_D$; $+2V_{G'} = 77.2^\circ$; $+2V_C = 77^\circ$.
220. $\text{Na}_2\text{Al}_2\text{H}_4\text{Si}_3\text{O}_{12}$ *ca.*, Natrolite (32, 148)

λ	α	β	γ
589D	1.475	1.479	1.489
	1.478	1.481	1.491
λ	$\delta\alpha_D$	$\delta\beta_D$	$\delta\gamma_D$
535Tl	25	25	28
671Li	-24	-26	-29

221. $\text{Na}_4\text{Al}_3\text{Si}_9\text{O}_{24}\text{Cl}$ *ca.*, Marialite (11, 58, 74, 114, 194); with
 $589D$, $\omega = \epsilon = 1.533$; $\delta\omega_D = \delta\epsilon_D$ of Meionite (162)

λ	ω	ϵ
589D	1.568*	1.545*

* 50% Marialite + 50% Meionite.

222. BeNaPO_4 , Beryllonite (39); *cf.* (72)

λ	α	β	γ
535Tl	1.5544	1.5604	1.5636
589D	1.5520	1.5579	1.5608
671Li	1.5492	1.5550	1.5578
$-2V_{671} = 67^\circ 22'$; $-2V_D = 67^\circ 34'$; $-2V_{535} = 67^\circ 50'$.			

223. $\text{BeNaHSi}_3\text{O}_8$, Epididymite (70)

λ	α	β	γ
535Tl	1.5465	1.5466	1.5491
589D	1.5440	1.5441	1.5464
671Li	1.5416	1.5417	1.5438

224. $\text{MgNa}_2\text{2SO}_4 \cdot 4\text{H}_2\text{O}$, Blödite (192); p

λ	α	β	γ
535Tl	1.4843	1.4858	1.4888
589D	1.4825	1.4839	1.4866
671Li	1.4807	1.4820	1.4847

225. $\text{Na}_4\text{Al}_6\text{B}_6\text{Si}_{12}\text{H}_8\text{O}_{63}$, Na-tourmaline

Tourmaline is near $\text{Na}_4\text{Al}_{16}\text{B}_6\text{Si}_{12}\text{H}_8\text{O}_{63}$ and $\text{Mg}_{12}\text{Al}_{10}\text{B}_6\text{Si}_{12}\text{H}_8\text{O}_{63}$ (Mg-tourmaline), with various substitutions. Data read from curves (16, 57, 162, 172, 175, 240).

Na-tourmaline

λ	ω	$\omega - \epsilon$
589D	1.636	0.0172
λ	$\delta\omega_C$	$\delta\epsilon_C$
486F	94	87

Mg-tourmaline

λ	ω	$\omega - \epsilon$
589D	1.633	0.0195
λ	$\delta\omega_C$	$\delta\epsilon_C$
434G'	150	136+
486F	96	87
589D	29	26
656C	0	0

Either with *ca.* 7% Fe_2O_3 + 8% FeO

λ	ω	ϵ
589D	1.685	1.651
λ	$\delta\omega_C$	$\delta\epsilon_C$
486F	140	120

226. $\text{CaNa}_2\text{2CO}_3 \cdot 2\text{H}_2\text{O}$, Pirs-sonite (156)

λ	α	β	γ
535Tl	1.5070*	1.5120	1.5791
589D	1.5040	1.5089	1.5749
671Li	1.5013*	1.5061	1.5712

* From β , γ and $2V$.

227. Na, Ca, (Mn), Fe, Zr, etc. metasilicate, Eudialite (237)

λ	ω	ϵ
535Tl	1.6120	1.6142
589D	1.6084	1.6102
671Li	1.6042	1.6060

228. $4\text{Na}_2\text{O} \cdot \text{CaO} \cdot 0.4\text{Al}_2\text{O}_3 \cdot 2\text{CO}_2 \cdot 9\text{SiO}_2 \cdot 3\text{H}_2\text{O}$, Canerinite (1)

λ	ω	ϵ
486F	1.531	1.507
589D	1.525	1.502
656C	1.522	1.500

229. $(\text{NaAlSi}_3\text{O}_8)_x + (\text{CaAl}_2\text{Si}_2\text{O}_7)_y$, Feldspars; *see* 261

Includes: Albite (218) (for which $y = 0$), Andesine (229), Anorthite (159) (for which $x = 0$), Labradorite (229), Oligoclase (229).

229.—(Continued)

Dispersion for the range $700 > \lambda > 500$ is linear with respect to either average refractive index or molecular composition. Oligoclase (143, 202), andesine and labradorite (202).

For $x = 78$, $y = 22$, oligoclase (143):

Range of temp.	λ	τ_α	τ_β	τ_γ
0 to 150°	480	0.35	0.44	0.39
	671	0.27	0.38	0.37
150 to 300°	480	0.47	0.60	0.58
	671	0.44	0.50	0.49

230. $\text{Na}_2\text{Ca}_2\text{Al}_6\text{Si}_9\text{O}_{30} \cdot 8\text{H}_2\text{O}$ *ca.*, Mesolite (76); becomes uniaxial near 35°C

λ	α	β	γ
535Tl	1.5070	1.5072	1.5075
589D	1.5048	1.5050	1.5053
671Li	1.5019	1.5021	1.5024

231. $\text{BaNa}_4(\text{Ti}, \text{Zr})\text{O}_2(\text{Si}_2\text{O}_5)_5$, Leucosphenite (70)

231.1. KClO_4 (133, 251); P			
λ	α	β	γ
589D	1.4728	1.4736	1.4768
λ	$\delta\beta_D$	λ	$\delta\beta_D$
404Hg	101	546Hg	15
434G'	76	656C	-18
486F	43	706He	-29

 $\delta\alpha_D = \delta\beta_D$; $\delta\gamma_D = 1.03\delta\beta_D$; $2V_C = 50^\circ 15'$; $2V_F = 48^\circ 48'$
231.2. KIO_4 (133)

λ	ω	ϵ
434G'	1.6473	1.6804
436Hg	1.6468	1.6798+
486F	1.6346	1.6651
546Hg	1.6253	1.6535+
578Hg	1.6216	1.6492+
589D	1.6205	1.6479
656C	1.6151	1.6416

232. K_2SO_4 (133, 200, 203); P ; *cf.* Fig. 1

λ	α	β	γ
589D	1.4934	1.4946	1.4973
λ	$\delta\beta_D^*$	λ	$\delta\beta_D^*$
405Hg	113+	656C	-19+
434G'	84	706He	-31
486F	47		

 $\delta\alpha_D = \delta\beta_D = \delta\gamma_D$; $+2V_D = 67^\circ 20'$. For all colors if $20^\circ < t < 180^\circ$, $\tau_\alpha = \tau_\beta = -4.0$, $\tau_\gamma = -5.0$ (203).

* (133).

233. $\text{K}_2\text{S}_2\text{O}_6$ (167); P

λ	ω	ϵ
405Hg	1.4662	1.5370
436Hg	1.4631	1.5309
492Hg	1.4594	1.5237
546Hg	1.4567	1.518(6)
579Hg	1.4554	1.516(4)
623Hg	1.4544	1.5140
691Hg	1.4527	1.5110

234. $\text{K}_2\text{S}_2\text{O}_6$ (129); P

λ	α	β	γ
436Hg	1.5040	1.5805	1.621
486F	1.4993*	1.5732*	1.612
546Hg	1.4954	1.5673	
589D	1.4934*	1.5641*	1.602
656C	1.4909	1.5607	
691Hg	1.4900†	1.5591	1.596

* Interpolated.

† Corrected.

235. K_2SeO_4 (205); P

λ	α	β	γ
486F	1.5421	1.5460	1.5518
589D	1.5352	1.5390	1.5446
656C	1.5325	1.5362	1.5418

For all colors if $20^\circ < t < 50^\circ$, $\tau_\alpha = -5$, $\tau_\beta = -6$, $\tau_\gamma = -7+$.

236. KNO_3 , Niter (133); P ; for soda niter, *n.* 191.1

λ	α	β	γ
405Hg	1.3384	1.5299	1.5304
436Hg	1.3368	1.5224	1.5229
486F	1.3347	1.5139	1.5144
546Hg	1.3330	1.5072+	1.5077
589D	1.3320	1.5038	1.5042+
656C	1.3310	1.4998	1.5002
706He		1.4975	1.4979
768A'		1.4951	1.4955

237. KH_2PO_4 (200); *cf.* Fig. 1

λ	ω	ϵ
486F	1.5154	1.4734
589D	1.5095	1.4684
656C	1.5064	1.4664

238. KH_2AsO_4 (200)

λ	ω	ϵ
486F	1.5762	1.5252
589D	1.5674	1.5179
656C	1.5632	1.5146

239. KHCO_3 (133); P ; *cf.* Fig. 1

λ	α	β	γ
405Hg	1.387		
434G'	1.385	1.492	1.588
486F	1.383	1.487+	1.581
589D	1.380	1.482	1.573
656C	1.379	1.479+	1.569
768A'	1.377	1.476	1.564

240. KHC_2O_4 (Acid oxalate) (133); P ; *cf.* Fig. 1

λ	α	β	γ
404Hg			1.6004
436Hg	1.3791	1.5665+	1.5933
486F	1.3762	1.5602	1.5849
589D	1.3728	1.5518	1.5743
656C	1.3716	1.5482+	1.5700
668He	1.3714	1.5476+	1.5694
706He		1.5458	1.5673

241. $\text{KC}_6\text{H}_5\text{O}_4\text{S}$ (*p*-Phenol-sulfonate) (86); p

λ	α	β	γ
486F	1.5834	1.6222	1.7114
589D	1.5714	1.6079	1.6942
656C	1.5672	1.6033	1.6879

242. $\text{KC}_6\text{H}_5\text{O}_4\text{S} \cdot 2\text{H}_2\text{O}$ (*o*-Phenolsulfonate) (86); *p*

λ	α	β	γ
486F	1.5362	1.5796	1.6636
589D	1.5265	1.5677	1.6467
656C	1.5228	1.5634	1.6410

243. $\text{KC}_6\text{H}_2(\text{NO}_2)_3\text{O}$ (Picrate) (15); *P*

λ	α	β	γ
486F	1.577		
502He	1.560		2.046
588He	1.527	1.903	1.952
656C	1.517	1.842	1.916
668He	1.516	1.835	1.912

244. $2(\text{SbO} \cdot \text{K} \cdot \text{C}_4\text{H}_4\text{O}_6) \cdot \text{H}_2\text{O}$ (Tartrate) (200); *p*

λ	α	β	γ
486F	1.6325	1.6497	1.6511
589D	1.6199	1.6360	1.6375
656C	1.6148	1.6306	1.6322

245. $\text{K}_2\text{Zn}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2246. $\text{K}_2\text{Zn}(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2247. $\text{CdCl}_2 \cdot 2\text{KCl}$ (177)

λ	ω	ϵ
527E <i>ca.</i>	1.5965	1.5966
589D	1.5906	1.5907
687B <i>ca.</i>	1.5841	1.5842

248. $\text{CuCl}_2 \cdot 2\text{KCl} \cdot 2\text{H}_2\text{O}$ (59); *P*

λ	ω	ϵ
405Hg	1.6957	1.6439
436Hg	1.6807	1.6346
492Hg	1.6636	1.6235
546Hg	1.6530	1.6162
578Hg	1.6485	1.6133
623Hg	1.6438	1.6097

249. $\text{K}_2\text{Cu}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, Cyanochroite; see Table 2250. $\text{K}_2\text{Cu}(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2251. $\text{K}_2\text{PtC}_2\text{O}_4(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$ (Platonitritooxalate) (53); *p*

λ	α	β	γ
535Tl	1.5579	1.6510	1.770
589D	1.5450	1.6414	1.760
671Li	1.5343	1.6319	1.748

252. $\text{K}_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2253. $\text{K}_2\text{Fe}(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2254. $\text{K}_3\text{Fe}(\text{CN})_6$ (178)

λ	α	β	γ
589D	1.5660	1.5689	1.5831
687B <i>ca.</i>	1.5591	1.5615	1.5759

255. $\text{K}_2\text{Co}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2256. $\text{K}_2\text{Co}(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2257. $\text{K}_2\text{Ni}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2258. $\text{K}_2\text{Ni}(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2259. $\text{K}_6\text{Cr}_2(\text{CN})_{12}$ (50); *p*

λ	α	β	γ
535Tl	1.5268	1.5292	1.5423
589D	1.5221	1.5244	1.5373
671Li	1.5176	1.5198	1.5324

260. $\text{K}_2\text{UO}_2(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ (142.1); *P*

λ	α	β	γ
500	1.520	1.535	1.583
580	1.514	1.527	1.570
720	1.509	1.522	1.563

260.1. KBF_4 , Avogadrite (245.1)

λ	α	β	γ
577	1.325	1.325	1.325
589D	1.324	1.325	1.325
677	1.323	1.324	

261. KAlSi_3O_8 , Orthoclase; *P*; see also Microcline (261.1)

(A feldspar; others are: Albite (218), Andesine (229), Anorthite (159), Labradorite (229), Microcline (261.1), Oligoclase (229).

Orthoclase occurs in two optical orientations, crystal axis *a* is always near the α -axis, but crystal axis *b* is the γ -axis in normal orthoclase (adularia, etc.) and the β -axis in abnormal orthoclase. Here *b* and *e*, respectively, denote the γ and β indices for normal, and the β and γ indices for abnormal orthoclase. As temperature is increased, normal orthoclase ultimately becomes abnormal.

λ	α	<i>e</i>	<i>b</i>
589D*	1.5177	1.5217	1.5231
	1.5170	1.5211	1.5208
589D†	1.518	1.522	1.524
	1.523	1.527	1.529
λ	$\delta b_D \dagger$	λ	$\delta b_D \dagger$
434G'	101	656C	-24
486F	57	719a	-41
535Tl	26		

$$\delta\alpha_D = (0.98 \text{ to } 0.985)\delta b_D; \delta e_D = (1.005 \text{ to } 1.01)\delta b_D$$

λ	τ_α	τ_e	τ_b
	-50° to 150° (232)		
535-671	0.30	0.48	0.20
	150° to 400° (232)		
535-671	0.51	0.61	0.51
	0° to 150° (143)		
480	0.30	0.45	0.20
671	0.24	0.40	0.17
	150° to 300° (143)		
480	0.60	0.70	0.50
671	0.50	0.62	0.37

* For pure; extrapolated from impure specimens.

† From (30, 106, 232).

‡ From (30, 106, 139, 143, 232).

261.1. KAlSi_3O_8 , Microcline, a feldspar (57); see also Orthoclase (261)

λ	α	β	γ
589D	1.5188	1.5226	1.5253
λ	δb_D		
535Tl	30		
671Li	-30		

$$\delta\alpha_D = \delta\beta_D = \delta\gamma_D.$$

262. $\text{K}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2$, Leucite (164); weak birefringence; *n* = mean index; 750° is above inversion temperature

λ	n_{21°	n_{750°
434G'	1.5188	1.5053
486F	1.5146	1.5009
589D	1.5088*	1.4947*
656C	1.5061	1.4921
719a	1.5046	1.4903

λ	$\tau n \dagger$
Interval	
21 to 425° . . .	-0.80
425 to 585° . . .	-1.6

* At 425, 585, and 660° $n_D = 1.5058, 1.5033, 1.5000$, respectively.

† Between 500 and 750° is irregular due to inversion.

263. $\text{KH}_2\text{Al}_3\text{Si}_3\text{O}_{12}$, Muscovite (mica) (112, 157, 172)

λ	α	β	γ
589D	1.551	1.580	1.585

Addition of 5% Fe^{+++} increases α, β, γ by 0.0018, 0.0024, 0.0026, respectively. For sample with *ca.* 2.5% Fe^{+++} , $n_{635} - n_{671} = 0.006+$, whether *n* = α, β , or γ .

264. $\text{K}_2\text{Mg}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, Picromerite; see Table 2265. $\text{K}_2\text{Mg}(\text{SeO}_4)_2 \cdot 6\text{H}_2\text{O}$; see Table 2266. $\text{K}_2\text{Ca}(\text{SO}_4)_2 \cdot \text{H}_2\text{O}$, Syn-genite (72, 180); *P*; uniaxial for $\lambda = 706$ if $t = 127^\circ$, for $\lambda = 471$ if $t = 178^\circ$

λ	α	β	γ
589D	1.500+	1.517	1.518
λ	$\delta\alpha_D$	$\delta\beta_D$	$\delta\gamma_D$
471He	59	61	62
486F	49	50	51
502He	40	40+	41
706He	-31	-33	-36

If $10^\circ < t < 130^\circ$, $\tau_\alpha = \tau_\beta = -2.6$, $\tau_\gamma = -3.5$.

267. $\text{K}_2\text{O} \cdot 0.8\text{CaO} \cdot 0.16\text{SiO}_2 \cdot 1.6\text{H}_2\text{O}$ *ca.*, Apophyllite (59)

λ	ω	ϵ
405Hg	1.5496	1.5496
436Hg	1.5456	1.5459
492Hg	1.5403	1.5410
546Hg	1.5366+	1.5376+
578Hg	1.5349	1.5360+
623Hg	1.5329+	1.5342
671	1.5311	1.5325+

267.—(Continued)

Range: Dispersion, several % (201); $\omega_D = 1.535$ to 1.545; birefringence (231); $\omega_D - \epsilon_D = +0.0003$ to -0.0025 .

268. LiKSO_4 (241, 254); *p*

λ	ϵ	ω
486F	1.4759	1.4762
589D	1.4715	1.4721
656C	1.4697	1.4703

269. $\text{LiKPt}(\text{CN})_4 \cdot 3(?)\text{H}_2\text{O}$ (14); see Fig. 2

λ	α	β	γ
588He	1.6237	1.6278	2.292
656C	1.6183	1.6217	2.040
668He			2.014
706He			1.953

270. $\text{NaKC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ (Tartrate) (222); *P*

λ	α	β	γ
434G'	1.5014	1.5028	1.5075
486F	1.4962	1.4979	1.5022
589D	1.4899	1.4917	1.4954
656C	1.4872	1.4890	1.4926

If $-70^\circ < t < +40^\circ$, $\tau_\alpha = -6.5$, $\tau_\beta = -6.1$ for all colors, and $\tau_\gamma = -6.8$ for blue and -6.2 for red.

271. $\text{FeCl}_2 \cdot 3\text{KCl} \cdot \text{NaCl}$, Rin-neite (20)

λ	ω	ϵ
535Tl	1.5930	1.5939
589D	1.5886	1.5894
671Li	1.5836	1.5842

271.1. RbClO_4 (251); *P*

λ	α	β	γ
589D	1.4692	1.4701	1.4731
λ	$\delta\beta_D^*$	λ	$\delta\beta_D^*$
434G'	75	656C	-18

$\delta\alpha_D = \delta\beta_D$; $\delta\gamma_D = 1.01\delta\beta_D$; $2V_C = 55^\circ 12'$; $2V_P = 54^\circ 33'$.

* Curves, see 231.1.

272. Rb_2SO_4 (203); *P*

λ	α	β	γ
486F	1.5181	1.5183	1.5194
589D	1.5131	1.5133	1.5144
656C	1.5112	1.5113	1.5124

If $60^\circ < t < 180^\circ$, for all colors, $\tau_\alpha = -4$, $\tau_\beta = \tau_\gamma = -3+$.

273. $\text{Rb}_2\text{S}_2\text{O}_6$ (62); *P*

λ	ω	ϵ	$(\epsilon - \omega)^*$
405Hg	1.4672	1.528	0.0598
436Hg	1.4642	1.525	0.0572
486F	1.4613	1.5153	0.0541
539D	1.4565	1.5068	0.0505
656C	1.4544	1.5034	0.0491
691Hg	1.4534	1.5017	0.0485

* By interference.

274. Rb₂SeO₄ (205); *P*

λ	α	β	γ
486F	1.5586	1.5609	1.5655
589D	1.5515	1.5537	1.5582
656C	1.5487	1.5509	1.5554

If $20^\circ < t < 80^\circ$, for all colors, $\tau_\alpha = -4+$, $\tau_\beta = -5$, $\tau_\gamma = -6+$.

275. Rb₂Zn(SO₄)₂·6H₂O; see Table 2276. Rb₂Zn(SeO₄)₂·6H₂O; see Table 2277. Rb₂Cd(SO₄)₂·6H₂O; see Table 2278. Rb₂Cu(SO₄)₂·6H₂O; see Table 2279. Rb₂Cu(SeO₄)₂·6H₂O; see Table 2280. Rb₂Mn(SO₄)₂·6H₂O; see Table 2281. Rb₂Mn(SeO₄)₂·6H₂O; see Table 2282. Rb₂Fe(SO₄)₂·6H₂O; see Table 2283. Rb₂Fe(SeO₄)₂·6H₂O; see Table 2284. Rb₂Co(SO₄)₂·6H₂O; see Table 2285. Rb₂Co(SeO₄)₂·6H₂O; see Table 2286. Rb₂Ni(SO₄)₂·6H₂O; see Table 2287. Rb₂Ni(SeO₄)₂·6H₂O; see Table 2288. Rb₂Mg(SO₄)₂·6H₂O; see Table 2289. Rb₂Mg(SeO₄)₂·6H₂O; see Table 2290. Rb₂Mg(CrO₄)₂·6H₂O; see Table 2291. RbLiPt(CN)₄·3(?)H₂O (14)

λ	α	β	γ
588He	1.6204	1.6234	1.931
656C	1.6153	1.6176	1.827
668He			1.815

291.1. CsClO₄ (251); *P*

λ	α	β	γ
589D	1.4752	1.4788	1.4804

λ	$\delta\beta_D^*$	λ	$\delta\beta_D^*$
434G'	80+	656C	-19

$\delta\alpha_D = 0.98\delta\beta_D$; $\delta\gamma_D = 1.02 \times \delta\beta_D$; $-2V_C = -2V_F = 62.5^\circ$.

* Curves, see 231.1.

292. Cs₂SO₄ (203); *P*

λ	α	β	γ
486F	1.5660	1.5706	1.5725
589D	1.5598	1.5644	1.5662
656C	1.5573	1.5619	1.5637

292.—(Continued)

For all colors, if $20^\circ < t < 180^\circ$, $\tau_\alpha = -4$, $\tau_\beta = -3+$, $\tau_\gamma = -3$.

293. Cs₂S₂O₆ (61); *P*

λ	ω	ϵ
405Hg	1.5366	1.5640
436Hg	1.5328	1.5583
486F	1.5285	1.5518
492Hg	1.5282	1.5513
589D	1.5230	1.5438
656C	1.5207	1.5405
719a	1.5191	1.5382

294. Cs₂SeO₄ (205); *P*; cf. Fig. 1

λ	α	β	γ
486F	1.6070	1.6080	1.6084
589D	1.5989	1.5999	1.6003
656C	1.5955	1.5965	1.5969

For all colors, if $20^\circ < t < 80^\circ$, $\tau_\alpha = -7+$, $\tau_\beta = \tau_\gamma = -6$.

295. Cs₂Tl₂Cl₉ (155)

λ	ω	ϵ
535Tl	1.792	1.786
589D	1.784	1.774
671Li	1.772	1.762

296. Cs₂Zn(SO₄)₂·6H₂O; see Table 2297. Cs₂Zn(SeO₄)₂·6H₂O; see Table 2298. Cs₂Cd(SO₄)₂·6H₂O; see Table 2299. Cs₂Cu(SO₄)₂·6H₂O; see Table 2300. Cs₂Cu(SeO₄)₂·6H₂O; see Table 2301. Cs₂Mn(SO₄)₂·6H₂O; see Table 2302. Cs₂Mn(SeO₄)₂·6H₂O; see Table 2303. Cs₂Fe(SO₄)₂·6H₂O; see Table 2304. Cs₂Fe(SeO₄)₂·6H₂O; see Table 2305. Cs₂Co(SO₄)₂·6H₂O; see Table 2306. Cs₂Co(SeO₄)₂·6H₂O; see Table 2307. Cs₂Ni(SO₄)₂·6H₂O; see Table 2308. Cs₂Ni(SeO₄)₂·6H₂O; see Table 2308.1. Cs₂UO₂Cl₄ (142.1)309. Cs₂Mg(SO₄)₂·6H₂O; see Table 2310. Cs₂Mg(SeO₄)₂·6H₂O; see Table 2311. Cs₂Mg(CrO₄)₂·6H₂O; see Table 2

II. C-Table; Organic Compounds; C-Arrangement; v. Vol.

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CH₂I₂, Methylene iodide, liquid; for comparison only see Fig. 1

CH₃AsO₃, Methylarsenic acid (53)

λ	α	β	γ
535Tl	1.5105	1.5490	1.5499
589D	1.5074	1.5457	1.5463
671Li	1.5037	1.5415	1.5417

C₂H₄N₄, Dicyandiamide (86)

λ	α	β	γ
486F	1.5321	1.5579	1.870
589D	1.5212	1.5493	1.847
656C	1.5177	1.5454	1.835

C₂H₅NO₂, Glycocoll (117)

λ	α	β	γ
486F	1.5665	1.656	1.6758
687B	1.4985	1.6115	1.6588

C₂H₈N₂O₄·H₂O, Ammonium oxalate (133)

λ	α	β	γ
405Hg	1.4503	1.5658	1.6212
436Hg	1.4472	1.5606	1.6139
502He	1.4427	1.5528	1.6033
546He	1.4403	1.5489	1.5983
588He	1.4387	1.5458	1.5944
668He	1.4362	1.5417	1.5889
706He			1.5868

C₃H₆N₆, Melamine (86)

λ	α	β	γ
486F	1.4992	1.7656	1.9020
589D	1.4906	1.7429	1.8721
656C	1.4876	1.7340	1.8608

C₃H₆N₆O₆, Trimethylenetri-nitroamine (197)

λ	α	β	γ
447He	1.597	1.620+	1.624+
471He	1.592+	1.614+	1.618+
486F	1.589+	1.611+	1.615+
535Tl	1.582+	1.603	1.608
589D	1.5775	1.5966	1.6015
656C	1.573	1.591+	1.597

C₃H₁₂N₆O₃, Guanidine carbonate (18, 120)

λ	ω	ϵ
535Tl	1.5035*	1.4930*
589D	1.5000*	1.4895*
589D	1.4990	1.4962
671Li	1.4954*	1.4849*

* Recalculated from (18).

C₄H₂O₃, Maleic anhydride (138)

λ	α	β	γ
589D	1.4429	1.4781	1.6384
671Li	1.4397	1.4745	1.6313

C₄H₄INO₂, Iodosuccinimide (219)

λ	ω	ϵ
486F	1.7129	1.6909
535Tl	1.7033	1.6797
589D	1.6965	1.6726
656C	1.6903	1.6652
671Li	1.6896	1.6645

C₄H₆O₄, Succinic acid (86)

λ	α	β	γ
486F	1.4558	1.5410	1.6204
589D	1.4503	1.5338	1.6100
656C	1.4486	1.5315	1.6062

C₄H₆O₄, Dimethyl oxalate (86)

λ	α	β	γ
486F	1.4267	1.470+	1.563
589D	1.4177	1.461+	1.552
656C	1.416	1.460+	1.550

C₄H₈Cl₂O₂, Erythritoldichlorohydrin (52)

λ	ω	ϵ
535Tl	1.5568	1.5175
589D	1.5535	1.5149
671Li	1.5497	1.5119

C₄H₈N₂O₃·H₂O, Asparagine (178)

λ	α	β	γ
527E ca.	1.5513	1.5845	1.6238
589D	1.5476	1.5800	1.6190
687B ca.	1.5438	1.5752	1.6139

C₄H₉NO₆, Ammonium hydrogen tartrate (200)

λ	α	β	γ
486F	1.528	1.569	1.600
589D	1.519	1.561	1.591
656C	1.517	1.558	1.586

C₅H₁₀O₃, *l*- α -Arabinose (234)

λ	α	β	γ
589D	1.551	1.567	1.571

Dispersion same as for *d*- α -Lyxose.

C₅H₁₀O₃, *d*- β -Arabinose (234)

λ	α	β	γ
589D	1.555	1.573	1.577

Dispersion is ca. 15% > that for *d*- α -Lyxose.

C₅H₁₀O₃, *d*- α -Lyxose (234)

λ	α	β	γ
450	1.541	1.550	1.559
500	1.537	1.546	1.554+
589D	1.532	1.541	1.549
650	1.530	1.538+	1.547

C₅H₁₀O₃, *d*- α -Xylose (234)

λ	α	β	γ
589D	1.517	1.544	1.546

Dispersion is ca. 10% < that for *d*- α -Lyxose.

C₆H₆ClNO₂, Picolinic acid hydrochloride (116)

λ	α	β	γ
535Tl	1.4514	1.713	1.764
589D	1.4482	1.705	1.754
671Li	1.4438	1.695	1.741

C₆H₆N₄O₇, Ammonium pierate

λ	α	β	γ
486	1.543		
513	1.528	1.960	2.004
528	1.522	1.944	1.961
541	1.518	1.933*	1.933*
588	1.508+	1.872	1.908
668	1.499	1.81+	1.880
Lit.	(15)	(129)	(129)

* β and γ interchange orientations.

C₆H₆O₂, *o*-Dihydroxybenzene (86)

λ	α	β	γ
486F	1.6204	1.6314	1.7536
589D	1.6044	1.6139	1.7336
656C	1.5980	1.6073	1.7255

C₆H₆O₂, Resorcinol (86)

λ	α	β	γ
486F	1.5901	1.6372	1.6449
589D	1.5781	1.6197	1.6273
656C	1.5725	1.6132	1.6208

C₆H₆O₂, Hydroquinol (86)

λ	ω	ϵ
486F	1.6479	1.6420
589D	1.6325	1.6262
656C	1.6260	1.6195

$C_6H_{12}O_5 \cdot H_2O$, Rhamnose (55)			
λ	α	β	γ
434G'	1.53379	1.54222	1.54446
486F	1.52892	1.53724	1.53960
535Tl	1.52568	1.53388	1.53631
589D	1.52298	1.53106	1.53360
656C	1.52034	1.52838	1.53100
671Li	1.51986	1.52788	1.53052
$C_7H_6N_2O_4$, 2, 4-Dinitrotoluene (86)			
486F	1.452+	1.6771	1.7884
589D	1.442+	1.6619	1.7556
656C	1.439+	1.6567	1.7440
$C_7H_6N_2O_4$, 2, 6-Dinitrotoluene (86)			
486F	1.4875	1.6898	1.7621
589D	1.4788	1.6694	1.7340
656C	1.4755	1.6225	1.7245
$C_7H_{10}N_2O_7$, Dimethyl mono-ureidodihydroxysuccinate (135)			
$C_7H_{10}N_4O_5$, Isohydroxy-3, 7-dimethyluric acid (199)			
λ	α	β	γ
535Tl	1.503	1.521	1.679
589D	1.495	1.513	1.672
671Li	1.491	1.509	1.665
$C_7H_{13}NO_5$, Ammonium shikimate (66)			
486F	1.476	1.595	1.668
589D	1.470	1.586	1.652
656C	1.468	1.581	1.646
$C_7H_{14}O_5$, α -Methylrhamnoside (163)			
535Tl	1.539	1.543	1.543
589D	1.536	1.540	1.541
671Li	1.534	1.538	1.538
$C_7H_{14}O_6$, α -Methylgalactoside (163)			
535Tl	1.524	1.526	1.532
589D	1.521	1.523	1.529
671Li	1.520	1.522	1.527
$C_7H_{14}O_6$, β -Methyl-d-glucoside (198)			
λ	ω	ϵ	
535Tl	1.534	1.520	
589D	1.529	1.513	
671Li	1.527	1.511	
$C_7H_{14}O_6$, α -Methylmannoside (198)			
λ	α	β	γ
535Tl	1.531	1.533	1.539
589D	1.528	1.529	1.537
671Li	1.527	1.528	1.532
$C_8H_{17}ClN_2$, Isobutyraldazine chlorohydrate (142)			
$C_9H_6O_2$, α , γ -Diketohydrindene (153)			
λ	486F	589D	656C
ω	1.640	1.619	1.613; $\epsilon > \omega$
C_9H_9NO , 2-(α)-Ketotetrahydroquinoline (hydrocarbo-styryl) (8)			
λ	α	β	γ
535Tl	1.4821		1.8257
589D	1.4792	1.7095	1.8102

$C_9H_{12}N_4O_3$, Tetramethyluric acid (163)			
λ	α	β	γ
535Tl	1.545	1.616	1.764
589D	1.538	1.609	1.754
671Li	1.532	1.604	1.750
$C_9H_{14}N_2O_7$, Diethyl mono-ureidodihydroxysuccinate (135)			
535Tl	1.539	1.557	1.579
589D	1.537	1.554	1.577
671Li	1.535	1.553	1.576
$C_{10}H_4Cl_6O$, Hexachloro- β -keto-hydronaphthalene (99)			
535Tl	1.6429	1.646	1.651
589D	1.6375	1.643	1.649
671Li	1.6320	1.639	1.647
$C_{10}H_7Br$, Bromonaphthalene* *Liquid; for comparison only; see Fig 1.			
$C_{10}H_{20}O_2 \cdot H_2O$, <i>cis</i> -Terpine hydrate (5)			
λ	α	β	γ
535Tl	1.5073	1.5148	1.5272
589D	1.5049	1.5124	1.5243
671Li	1.5024	1.5093	1.5211
$C_{11}H_{21}NO_3$, <i>N</i> -Methyl-2, 2, 6, 6-tetramethyl-4-hydroxypiperidinecarboxylic acid (198)			
535Tl	1.541	1.5512	1.5591
589D	1.533	1.5459	1.5562
671Li	1.527	1.5412	1.5524
$C_{12}H_{20}O$, Matico camphor (89)			
λ	ω	ϵ	
535Tl	1.5488	1.5476	
589D	1.5447	1.5436	
671Li	1.5415	1.5404	
$C_{12}H_{22}O_{11}$, Saccharose (cane sugar) (133)			
λ	α	β	γ
405Hg	1.5524	1.5803	1.5858
436Hg	1.5484	1.5762+	1.5816+
502He	1.5425	1.5702	1.5756
546Hg	1.5397+	1.5673	1.5727
588He	1.5377	1.5652	1.5706
706He	1.5336	1.5610+	1.5664
$C_{14}H_{12}O$, Phenyl <i>p</i> -tolyl ketone (19)			
λ	ω	ϵ	
535Tl	1.725	1.569	
589D	1.717	1.563	
671Li	1.707	1.556	
$C_{14}H_{12}O_3$, Amyrolin (168*)			
λ	α	β	γ
405Hg	1.4838	1.8558	2.1989
436Hg	1.4778	1.8164	2.0986
492Hg	1.4713	1.7791	2.0126
546Hg	1.4669	1.7588	1.9684
579Hg	1.4650	1.7504	1.9505
589D	1.4645	1.7480	1.9458
623Hg	1.4630	1.7412	1.9326
691Hg	1.4604†	1.7323	1.9138
* Accuracy of data cannot be closely estimated. † In original, 1.4589.			
$C_{15}H_{12}O_2$, Dibenzoylmethane (enol form) (166)			
420 ca.	1.7354	1.8800	2.3960†
440 ca.	1.7206	1.7919	2.2356†
480 ca.	1.7031	1.7264	2.0989†

$C_{15}H_{12}O_2$ —(Continued)			
λ	α	β	γ
526 ca.*	1.6913	1.6913	2.0242†
580 ca.	1.6817†	1.6672§	1.9746†
720 ca.	1.6697†	1.6401§	1.9185†
* α and β interchange as λ passes through 526. † Quite uncertain. ‡ β . § α .			
$C_{16}H_{10}O_3$, Diphenylmaleic anhydride (42)			
$C_{16}H_{14}O$, Benzylidene <i>p</i> -tolyl ketone (181)			
λ	α	β	γ
535Tl	1.634+	1.653	1.935
589D	1.620+	1.642+	1.909
671Li	1.607+	1.634	1.881
$C_{16}H_{14}O_2$, <i>p</i> -Tolylacetophenone (enol form) (166)			
438	1.690	1.805	2.36
459.3	1.679	1.758	2.23
500	1.663	1.711	2.12
552	1.650	1.680	2.03
646.5	1.638	1.652	1.95
$C_{17}H_{23}NO_4$, Menthyl <i>o</i> -nitrobenzoate (79)			
535Tl	1.5003	>1.505	1.5781
589D	1.4966	1.5015*	1.5722
671Li	1.4927	<1.498	1.5659
* Recalculated.			
$C_{17}H_{24}O_{10}$, Ethyl tetraacetylquininate (87)			
535Tl	1.4931	1.5071*	1.5172
589D	1.4897	1.5037*	1.5138
671Li	1.4869	1.5010*	1.5111
* Recalculated.			
$C_{18}H_{15}BiCl_2$, Triphenylbismuth dichloride (81)			
436Hg	1.785	1.788+	1.848
546Hg	1.744+	1.745	1.803
589D	1.734*	1.735*	1.795
* α and β interchange between $\lambda = 589$ and $\lambda = 546$.			
$C_{18}H_{21}NO_3 \cdot H_2O$, Codeine (86)			
486F	1.5507	1.6514	
589D	1.5428	1.6355	1.6838
656C	1.5402	1.6285	1.6730

TABLE 2, see p. 31-32

TABLE 3.—WAVE-LENGTHS CORRESPONDING TO VARIOUS SYMBOLS
Unit of $\lambda = 10 \text{ \AA} = 1 \text{ m}\mu = 10^{-7} \text{ cm}$

Sym- bol	λ	Sym- bol	λ	Sym- bol	λ
226Cd	226.503	455Ba	455.40	578Hg	579.07
231Cd	231.288	468Cd	467.82		576.96
257Cd	257.304	471He	471.31	588He	587.56
275Cd	274.867	480Cd	479.99	589D	589.00Na
340Cd	340.365	486F	486.13H β		589.59Na
347Cd	346.69	492Hg	491.60	623Hg	623.44
361Cd	361.25	492He	492.19	644Cd	643.85
393K	393.37Ca	502He	501.57	656C	656.28H α
397H	396.85Ca	508Cd	508.58	668He	667.81
410h	410.17H δ			671Li	670.79
405Hg	404.66	527E	526.95Fe	691Hg	690.75
			527.03Ca	687B	687.1 ca.
431G	430.77Ca	535Tl	535.05	706He	706.52
	430.79Fe	538Cd	537.89	719a	718.9 ca.
434G'	434.05H γ	546Hg	546.07	760A	759.41
436Hg	435.83	561Pb	560.88		762.13
447He	447.15			768A'	768.19K

TABLE 2.—REFRACTION OF PURE SULFATES, SELENATES AND CHROMATES OF THE TYPE $R''R_2(SO_4)_2 \cdot 6H_2O$

The data relating to dispersion (in air at room temperature) have been determined from curves that take account of the similarities of all these sulfates and selenates. In most cases, approximate measurements (²⁰⁴) have been made for $\lambda = G' = 434m\mu$, but, excepting the Tl-salts, more accurate values can be derived from the relations: $(\beta_{G'} - \beta_F) = 0.76(\beta_F - \beta_C)$ for the sulfates, and $(\beta_{G'} - \beta_F) = 3.79(\beta_F - \beta_C)$ for the selenates. For a few of the salts, more complete dispersion data ($\delta\beta_D$, etc.) are given at the end of the Table, where $10^{-4}\delta\beta_D = \beta_\lambda - \beta_D$. The apparent uncertainties in the less accurate values of $2V_C$ and of $2(V_F - V_C)$ are indicated by a ($=7'$), b ($=12'$), c ($=25'$), and d ($=60'$). $10^{-6}\tau\beta_D = d\beta_D/dt$, if $10^\circ < t < 80^\circ$; $(\alpha_F - \alpha_C) = (\beta_F - \beta_C + \Delta\alpha)$; $(\gamma_F - \gamma_C) = (\beta_F - \beta_C + \Delta\gamma)$. For more exact wave-lengths corresponding to symbols for λ , see Table 3, p. 30. Unit of $\Delta\alpha$, $\Delta\gamma$, $(\beta_D - \beta_C)$, and $(\beta_F - \beta_D) = 10^{-4}$; of $\lambda = 10 \text{ \AA} = 1m\mu = 10^{-7} \text{ em.}$

R''	R	α_D	β_D	γ_D	$\Delta\alpha$	$\beta_D - \beta_C$	$\beta_F - \beta_D$	$\Delta\gamma$	$2V_C$	$2(V_F - V_C)$	$\tau\alpha_D$	$\tau\beta_D$	$\tau\gamma_D$	Lit.
R'' R ₂ (SO ₄) ₂ ·6H ₂ O														
Zn	K.....	1.4775	1.4834	1.4968	-2	24	54	4	68° 16'	- 0° 7'		-3+		(151, 204)
	Rb.....	1.4833	1.4883	1.4975	-2	24	55	3	73 40 ^b	- 0 22 ^b		-2+		(152, 204)
	Cs.....	1.5021	1.5049	1.5094	-1	25	57	2	74 27 ^b	- 0 54 ^b		-3		(151, 204)
	NH ₄	1.4889	1.4932	1.4994	-2	26	60	2	78 58	+ 0 5	-2+	-3	-4	(151, 209)
	Tl.....	1.5933	1.6093	1.6170	-9	47	111	12	-67 54 ^c	+ 2 12 ^c				(133, 152, 212)
Cd	Rb.....	1.4799	1.4849	1.4950	-2	24	58	4	72 21 ^c	+ 0 2 ^c				(204)
	Cs.....	1.4975	1.5006	1.5062	-2	25	59	4	68 2 ^b	- 0 34				(204)
	NH ₄	1.4847	1.4887	1.4959	-1	26	61	2	72 46 ^b	+ 0 15				(214)
	Tl**.....	1.4836	1.4864	1.5020	-3	26	58	4	46 6 ^b	+ 1 27 ^c		-4		(204)
Cu	Rb.....	1.4886	1.4906	1.5035	-2	26	59	5	44 29 ^b	+ 0 46		-3		(152, 204)
	Cs.....	1.5048	1.5061	1.5153	-1	26	61	2	43 9 ^b	+ 0 54		-3		(204)
	NH ₄	1.4910	1.5007	1.5054	-6	27	63	-1	-68 57 ^b	- 2 0 ^b	-1	-4	-5	(133, 214)
	Tl**.....	1.600	1.610	1.619	-2	46	126	2	-85 21	- 0 19				(252)
	Rb.....	1.4766	1.4808	1.4908	-2	23	54	4	67 8	- 0 13		-3+		(152, 204)
Mn	Cs.....	1.4946	1.4966	1.5025	-1	25	58	2	60 7	- 0 29		-3+		(204)
	NH ₄	1.4801	1.4840	1.4913	0	25	58	1	69 46	+ 0 16	-3+	-3+	-3+	(214)
	Tl**.....	1.586	1.600	1.608	(?)	36(?)	110	(?)	-71 16	0 43				(252)
	K.....	1.4759	1.4821	1.4969	-2	24	55	4	67 2 ^b	+ 0 17		-2+		(204)
	Rb.....	1.4814	1.4873	1.4978	-2	24	56	3	73 23	- 0 10		-3+		(152, 204)
Fe	Cs.....	1.5003	1.5035	1.5094	-1	25	58	2	75 0 ^b	- 0 29 ^a		-3+		(204)
	NH ₄	1.4870	1.4915	1.4991	-1	25	58	2	76 18	+ 0 15	*	-3+	*	(213)
	Tl**.....	1.5929	1.6093	1.6162	(?)	45	116	(?)	-68 46	1 13				(252)
	K.....	1.480+	1.486+	1.500+	-2	24	54	4	68 39 ^c	+ 0 9		-4		(133, 204)
	Rb.....	1.486	1.491+	1.501+	-2	24	53	3	75 14 ^b	- 0 11 ^a		-3+		(152, 204)
Co	Cs.....	1.505+	1.508+	1.513+	-1	25	56	2	81 40 ^b	- 0 18 ^a		-3+		(204)
	NH ₄	1.4902	1.4953	1.5032	-2	26	60	3	82 25	+ 0 25	-4	-4+	-5	(133, 214)
	Tl.....	1.6009	1.6176	1.6238	(?)	48	117	(?)	-66 6 ^b	+ 2 0 ^c				(219)
	K.....	1.4836	1.4916	1.5051	-3	24	55	4	75 19	- 0 10		-2+		(204)
	Rb.....	1.4895	1.4963	1.5054	-2	24	56	3	82 4 ^b	- 0 16 ^a		-3		(152, 204)
Ni	Cs.....	1.5087	1.5129	1.5162	-1	25	58	1	-87 17	+ 0 23		-3		(204)
	NH ₄	1.4949	1.5007	1.5081	-3	26	60	3	86 28	+ 0 15	-3+	-3+	-4	(133, 214)
	Tl.....	1.6025	1.6184	1.6252	-4	49	116	8	-60 0 ^c	+ 2 12 ^c				(133, 219)
	K.....	1.4607	1.4629	1.4755	-1	22	51	4	48 0 ^b	- 0 19 ^b		-4		(204)
	Rb.....	1.4671	1.4689	1.4780	-0.5	22	52	2	49 2	- 0 52		-2+		(152, 204)
Mg	Cs.....	1.4857	1.4858	1.4916	+0.5	24	55	1	18 0 ^c	- 6 45 ^c		-3		(204)
	NH ₄	1.4716	1.4730	1.4786	-0	25	56	1	51 18	- 0 42 ^b	-3†	-3+†	-4†	(209)
	Tl**.....	1.5705	1.5884	1.5949	-6	46	108	4	-74 42	0 52				(252)
R'' R ₂ (SeO ₄) ₂ ·6H ₂ O														
Zn	K.....	1.512	1.518	1.533+	-3	31	70	8	66 13	+ 0 7		-4+		(206)
	Rb.....	1.5162	1.522	1.533	-2	31	71	6	75 14 ^c	- 0 19		-4		(206)
	Cs.....	1.532+	1.5362	1.541	-0	31	73	4	83 30	- 0 16 ^b		-3+		(206)
	NH ₄	1.5240	1.5300	1.5385	-2	33	78	2	82 5	+ 0 5	-2‡	-2+	-3	(209)
	Tl**.....	1.641	1.654	1.661	(?)	58	167(?)	(?)	-68 15	1 15				(253)
Cd	NH ₄	1.5206	1.5260	1.5352	0	33	78	0	76 11 ^c	+ 0 49 ^c				(217)
	K.....	1.5101	1.5228	1.5349	-5	32	76	1	88 46 ^b	- 1 10 ^c		-3+		(218)
	Rb.....	1.5153	1.5183	1.5318	-3	32	75	6	53 0 ^b	+ 0 43 ^b		-3		(218)
	Cs.....	1.5282	1.5298	1.5394	-0	32	75	1	48 20 ^b	+ 0 22 ^b		-2+		(218)
Cu	NH ₄	1.5201	1.5344	1.5387	-2	34	80	2	-55 42	- 1 54 ^b		-3		(218)
	Tl**.....	1.640	1.656+	1.672	-7	54	144	7	-85 13	- 0 17				(253)
	Rb.....	1.5094	1.5140	1.5258	-1	31	71	7	66 5 ^b	- 0 13		-2+		(218)
	Cs.....	1.5250	1.5279	1.5338	+1	31	74	6	69 1 ^b	- 0 56	-2	-2+	-3	(217, 218)
	NH ₄	1.5160	1.5202	1.5288	-2	32	75	4	70 18 ^b	+ 0 16		-2		(218)
Mn	Tl**.....	1.628	1.643	1.653	-6	59	150	6	-72 4	1 28				(253)
	K.....	1.5095	1.5182	1.5345	-3	32	72	6	64 12 ^a	+ 0 24				(218)
	Rb.....	1.5133	1.5200	1.5328	-3	31	72	6	73 24	- 0 8	-3	-3+	-4	(218)
	Cs.....	1.5306	1.5352	1.5414	-2	32	74	2	82 56 ^b	- 0 36 ^a		-2+		(218)
	NH ₄	1.5216	1.5280	1.5381	-1	33	76	1	77 37	+ 0 17	-2+	-3	-3+	(216, 218)
Fe	Tl**.....	1.6352	1.6514	1.6589	-3	55	148	3	-69 5	1 40				(253)
	K.....	1.5158	1.5218	1.5380	-2	32	74	5	62 13	+ 0 30 ^b		-4		(218)
	Rb.....	1.5199	1.5256	1.5369	-2	32	76	4	73 41 ^b	- 0 20 ^b		-4		(218)
	Cs.....	1.5354	1.5399	1.5453	-2	33	77	4	87 18 ^b	- 1 15 ^c		-3		(218)
	NH ₄	1.5261	1.5327	1.5417	-2	33	77	4	82 6	+ 0 30 ^b		-2		(218)
Co	Tl**.....	1.644	1.653	1.659	(?)	40(?)	111(?)	(?)	-66 15	1 21				(253)
	K.....	1.5181	1.5272	1.5427	-3	33	76	6	72 45	+ 0 11 ^a		-3+		(218)
	Rb.....	1.5198	1.5291	1.5390	-3	32	73	4	82 22	- 0 24 ^a		-3		(218)
	Cs.....	1.5395	1.5450	1.5489	-2	33	76	3	-82 43 ^b	+ 1 0 ^b	-2+	-3	-3+	(215, 218)
	NH ₄	1.5285	1.5370	1.5460	-2	33	78	2	86 19	+ 0 10		-3+		(218)

TABLE 2.—(Continued)

R''	R	α_D	β_D	γ_D	$\Delta\alpha$	$\beta_D - \beta_C$	$\beta_F - \beta_D$	$\Delta\gamma$	2V _C	2(V _F - V _C)	$\tau_{\alpha D}$	$\tau_{\beta D}$	$\tau_{\gamma D}$	Lit.
Ni	Tl**	1.638	1.650	1.656	(?)	39(?)	145	(?)	-58° 10'	2° 43'				(253)
Mg	K	1.4970	1.4991	1.5138	-1	29	63	6	39 42 ^b	- 0 17		-3+		(207)
	Rb	1.5011	1.5031	1.5135	-1	29	67	5	47 24	- 1 18 ^b		-3		(207)
	Cs	1.5178	1.5179	1.5236	+2	30	70	3	20 34 ^b	-10 4 ^b		-3		(207)
	NH ₄	1.5070	1.5093	1.5169	0	31	72	4	54 54 ^b	- 0 51	-1+¶	-3¶	-3¶	(133, 209)
	Tl**	1.625	1.633+	1.640+	(?)	40(?)	115(?)	(?)	-77 20	0 50				(253)

R'' R₂(CrO₄)₂.6H₂O

Mg	Rb	1.6215	1.6330	1.6435	-42	100	356	13	-88 4 ^b	+ 6 4 ^b	-3	-4	-4	(220)
	Cs	1.6369	1.6424	1.6546	-12	94	332	31	+67 7 ^b	- 2 20 ^c		-4+		(220)
	NH ₄	1.6361	1.6372	1.6530	-83	100	356	78	8 54 ^a	+41 0 ^d		-4		(133, 220)

R''R₂(SO₄)₂.6H₂O (133)

λ	$\delta\beta_D$	λ	$\delta\beta_D$
R'' = Zn, R = Tl			
434G'	202	434G'	107
436Hg	198+	486F	60+
486F	111	656C	- 26
502He	88+	$\delta\alpha_D = 0.95\delta\beta_D$	
535Tl	49+		
546Hg	37+		
578Hg	8+		
656C	- 47		
668He	- 53+		
671Li	- 55		
$\delta\alpha_D = 0.94\delta\beta_D$			
$\delta\gamma_D = 1.075\delta\beta_D$			

R'' = Co, R = K	
405Hg	126
434G'	95
486F	54
535Tl	25
656C	- 24
706He	- 38+
$\delta\alpha_D = 0.96\delta\beta_D$	
$\delta\gamma_D = 1.06\delta\beta_D$	

R'' = Ni, R = Rb	
434G'	97
486F	55
656C	- 24
687B	- 33
$\delta\alpha_D = 0.97\delta\beta_D$ ca.	
$\delta\gamma_D = 1.04\delta\beta_D$ ca.	

R'' = Ni, R = Tl	
436Hg	207
486F	116
535Tl	52
656C	- 49
668He	- 58
$\delta\alpha_D = 0.97\delta\beta_D$	
$\delta\gamma_D = 1.05\delta\beta_D$	

Mg(NH₄)₂(SeO₄)₂.6H₂O (133)

λ	$\delta\beta_D$	λ	$\delta\beta_D$
405Hg	171	434G'	129
486F	71+	535Tl	32+
656C	- 30+	706He	- 49+
$\delta\alpha_D = \delta\beta_D, \delta\gamma_D = 1.05\delta\beta_D$			

Mg(NH₄)₂(CrO₄)₂.6H₂O (133)

λ	$\delta\alpha_D$	$\delta\beta_D$	$\delta\gamma_D$
486F	326	356	414
492He		319	
502He		271	315
509Cd	219	239	277
535Tl	126	138	159
546Hg		104	
578Hg		24	
588He		3	3
656C	- 92	-100	-115
668He		-122	-140
671Li	-114	-124	-142

* For Fe(NH₄)₂(SO₄)₂.6H₂O, $\tau_{\alpha F} = -2.2$, $\tau_{\beta F} = -2.8$, $\tau_{\gamma F} = -3.2$; and for red, $\tau_{\alpha} = -2.8$, $\tau_{\beta} = -4.0$, $\tau_{\gamma} = -3.6$.
† For Mg(NH₄)₂(SO₄)₂.6H₂O, values of τ apply to all colors.
‡ For Ni (NH₄)₂(SO₄)₂.6H₂O, strong absorption of γ at $\lambda = 405$ and 706 .
§ For Zn(NH₄)₂(SeO₄)₂.6H₂O, $\tau_{\alpha F} = -1+$, $\tau_{\alpha Li} = -2+$.
¶ Recalculated.
¶ For Mg(NH₄)₂(SeO₄)₂.6H₂O, values of τ apply if $486F < \lambda < 671Li$.
** Accuracy of 2V, and 2(V_F - V_C) not estimated.

TABLE 4.—CONVERSION OF TEMPERATURE COEFFICIENTS OF REFRACTION FROM VACUUM TO AIR

Assuming that the air and crystal are at the same temperature, and writing $10^{-5}\tau = d(index)/dt$, and $\Delta = \tau_{air} - \tau_{vac}$, Δ is directly proportional to the pressure of the air, and increases by 2% in going from the red ($\lambda = 650m\mu$) to the violet ($\lambda = 400m\mu$). The tabulated values refer to $\lambda = 650m\mu$ and air at a pressure of 760 mm of Hg.

Index	1.3	1.7	2.2	3.0
Range, °C				
Δ				
-100 to -50	0.25	0.32	0.42	0.58
- 50 to 0	0.17	0.22	0.29	0.39
0 to 50	0.12	0.15	0.20	0.27
50 to 150	0.08	0.10	0.13	0.17+
150 to 300	0.04	0.06	0.07	0.10
0 to 150	0.09	0.12	0.15	0.21

LITERATURE

(For a key to the periodicals, see end of volume)

(1) Albis, 22, 30 II: 472; 21. (2) Aminoff, 94, 60: 262; 21. (3) Aminoff, 207, 43: 24; 22. (4) Aminoff, 207, 45: 160; 23. (5) Arzruni, 8, 2: 282; 74. (6) Arzruni, 94, 1: 165; 77. (7) Arzruni, 94, 1: 434; 77. (8) Bäckström, 94, 17: 427; 90. (8¹) Baeuvier, 191, 45: 73; 22. (9) Baerwald, 94, 7: 167; 83. (10) Baker, 4, 47: 353; 85. (11) Baeklund, 134, 11: 19; 17. (12) Baumhauer, 94, 44: 23; 07. (13) Baumhauer, 94, 45: 555; 08. (14) Baumhauer, 94, 47: 1; 10. (15) Baumhauer, 94, 49: 113; 11. (16) Beeht, Diss., Heidelberg, 1913. (17) Behr, 192, 1903 I: 135. (18) Bodewig, 8, 157: 122; 76. (19) Bodewig, 8, 158: 232; 76.
(20) Boeke, 190, 1909 II: 19. (21) Borel, 34, 120: 1404; 95. (22) Borgström, 94, 54: 238; 15. 57: 218; 22. (23) Born, 190B, 5: 1; 87. (24) Bowen, 12, 33: 551; 12. (25) Bowen and Andersen, 12, 37: 487; 14. (26) Bowman, 269, 13: 324; 03. (27) Brauns, 189, 1909: 673. (28) Brauns, 190, 1917 I: 9. (29) Brauns, 190B, 41: 60; 16.
(30) Bräutigam, 481, 35: 231; 22. (31) Brögger, 94, 18: 377; 91. (32) Brögger, 94, 16: 615; 90. (33) Busz, 190B, 5: 330; 87. (34) Busz, 190B, 39: 482; 14. (35) Busz and Rüsberg, 189, 1913: 625. (36) Carvallo, 34, 126: 950; 98. (37) Carvallo, 51, 9: 465; 00. (38) Crandall, 2, 2: 343; 13. (39) Dana and Wells, 12, 37: 23; 89.

- (40) Delhay, 191, 41: 80; 18. (41) des Cloizeaux, B3. (42) Drugman, 94, 50: 576; 12. (43) Dübik, 190B, 36: 214; 13. (43.1) Dufet, 191, 1: 58; 78. (43.2) Dufet, 191, 3: 180; 80. (44) Dufet, 191, 8: 262; 85. (45) Dufet, 191, 10: 77; 87. (46) Dufet, 191, 10: 214; 87. (47) Dufet, 191, 11: 123; 88. (48) Dufet, 191, 16: 149; 93. (49) Dufet, 191, 21: 90; 98.
- (50) Dufet, 191, 24: 118; 01. (51) Dufet, 191, 24: 373; 01. (52) Dufet, 191, 25: 38; 02. (53) Dufet, 191, 25: 125; 02. (54) Dufet, 191, 26: 65; 03. (55) Dufet, 191, 27: 146; 04. (56) Dufet, *Recueil de données numériques optiques*. Paris, 1900. (57) Duparc, Wunder and Sabot, 463, 36: 283; 10. (58) von Eekermann, 207, 44: 203; 22. (59) Ehringhaus, 190B, 41: 342; 17.
- (60) Ehringhaus, 190B, 43: 557; 20. (61) Ehringhaus and Rose, 94, 58: 460; 23. (62) Ehringhaus and Rose, 94, 59: 249; 24. (63) Eissner, *Diss.*, Leipzig, 1913. (64) Eppler, 190, 55A: 401; 27. (64.1) Ernst, 190B, 52: 113; 25. (64.2) Erofejeff, 75, 56 II: 63; 67. (65) Eskola, 12, 4: 331; 22. (66) Eijkman, 25, 24: 1278; 91. (66.1) Ferguson and Merwin, 12, 48: 81; 19. (67) Fischer, 94, 61: 226; 25. (68) Fischer, 190B, 32: 1; 11. (69) Flink, *Bull. Geol. Inst. Upsala*, 5: 81; 02.
- (70) Flink and Winter, *Meddel. Gröndland Copenhagen*, 24: 180; 01. 94, 34: 639; 00. (71) Fitz and Sansoni, 94, 6: 67; 82. (72) Gaubert, 191, 30: 104; 07. (73) Gaubert, 191, 40: 177; 17. (74) Gaubert, in Lacroix, 34, 169: 261; 19. (75) Gifford, 5, 70: 329; 02. 84: 193; 10. (76) Görgey, 481, 28: 77; 09. (77) Goldschlag, 481, 34: 23; 17. (78) Goldschmidt and Müller, 94, 48: 473; 11. (78.2) Graber, 2, 26: 380; 25. (79) Graham, 4, 87: 1193; 05.
- (80) Grandinger, *Diss.*, Leipzig, 1919. 94, 56: 631; 22. (81) Greenwood, 269, 20: 123; 23. (81.1) Groth, *Chemische Krystallographie*. Leipzig, Engelmann, 1906-1919. (82) Hadding, 207, 36: 319; 14. (83) Hatley, 2, 24: 486; 24. (84) Herbette, 191, 29: 97; 06. (85) Heusser, 8, 87: 454; 52. (86) Heydrich, 94, 48: 243; 10. (87) Hillebrand, 94, 1: 303; 77. (88) Himmelsbauer, 75, 119 I: 115; 10. (89) Hintze, 8, 157: 127; 76. (89.1) Hintze, 94, 7: 296; 83.
- (90) Hlawatsch, 481, 23: 415; 04. (91) Hörner, *Diss.*, Heidelberg, 1915. (92) Hövermann, 190B, 34: 321; 12. (93) Hofmann-Degen, 171, 10A: No. 14; 19. (94) Hutchinson, 269, 13: 209; 03. (95) Hutchinson, 94, 43: 461; 07. (96) Hutchinson, 133, 1908: 701. (97) Hutchinson and Tutton, 94, 52: 218; 13. (98) Ites, *Diss.*, Göttingen, 1903. 94, 41: 304; 06. (99) Janssen, 94, 17: 225; 90.
- (100) Ježek, 94, 54: 191; 15. (101) Karandéeff, 189, 1910: 17. (101.1) Kayser, *Tabelle der Hauptlinien der Linienspektren*. Berlin, Springer, 1926. (102) Klein, 190, 1875: 337. (102.1) Kohlrausch, 8, 4: 1; 78. (103) Kolb, 94, 49: 14; 11. (104) Koller, 190B, 42: 457; 19. (105) Kôzu, 159B, 2: 7; 14. (106) Kôzu, 269, 17: 189, 237, 253; 16. (107) Kraus and Peek, *Mich. Acad. Sci., Rept.*, 1917: 95. (108) Kraus and Reiting, 94, 34: 268; 01. (109) Kreutz, 75, 117 I: 877; 08.
- (110) Kreutz, 190, 1918: 134A. (111) Kruse, 190B, 27: 541; 09. (112) Kunitz, 190B, 50: 365; 24. (113) Lacroix and Rengade, 191, 34: 123; 11. Lacroix, 191, 35: 200, 236; 12. (114) Laitakari, 94, 57: 212; 22. (115) Landolt-Börnstein, B3. (116) von Lang, 75, 111 IIa: 1161; 02. (116.1) Larsen, 156, No. 679; 21. (117) Lebedev, 10, 4: 1026; 22. (117.1) Manasse, 22, 19: 211; 10. (118) Marbach, *Diss.*, Leipzig, 1913. (119) Martens, 8, 6: 603; 01. 8: 459; 02.
- (120) Martin, 190B, 7: 1; 91. (120.1) Matossi and Dane, 96, 45: 501; 27. (121) Melezer, 94, 33: 240; 00. (122) Melezer, 94, 35: 561; 02. (123) Merwin, *see* (24). (124) Merwin, 12, 34: 341; 12. (125) Merwin, 128, 5: 341; 15. (126) Merwin, 128, 7: 445; 17. (129) Merwin, 128, 9: 429; 19.
- (130) Merwin, 1, 42: 2432; 20. (133) Merwin, O. (134) Micheli, 8, 7: 772; 02. (134.1) Miller, 48, 10: 621; 25. (135) Monke, 13, 306: 38; 99. (136) Moroschkina, 94, 63: 371; 26. (137) Mountain, 269, 21: 51; 26. (138) Mügge, 189, 1915: 481. (139) Mülheims, 94, 14: 202; 88.
- (140) Müller, 190B, 17: 187; 03. (142) Munteanu-Murgoci, 481, 18: 504; 99. (142.1) Nichols and Howes, 162, No. 298: 207; 19. (143) Offret, 191, 13: 405; 90. (144) Ohm, 190B, 13: 1; 01. (145) Oppenheimer, *Diss.*, Heidelberg, 1914. (146) Palache, 94, 47: 576; 10. (147) Panichi, 170, 6: 38; 06. (147.1) Parry and Wright, 269, 20: 285; 25. (148) Pelikan, 75, 111 I: 334; 02. (149) Penfield and Ford, 12, 22: 61; 06.
- (150) Penfield and Minor, 94, 23: 321; 91. (151) Perrot, 149, 25: 26; 91. (152) Perrot, 149, 29: 28, 121; 93. (153) Pichetto, 22, 31 II: 113; 22. (154) Plathan, in (81.1), III: 15; 10. (154.1) Posnjak and Merwin, 12, 47: 311; 19. (154.2) Posnjak and Merwin, 1, 44: 1965; 22. (155) Pratt, 12, 49: 397; 95. (156) Pratt, 12, 2: 123; 96. (157) Pulfrich, 8, 30: 487; 87. (158) Quereigh, 22, 21 I: 581; 12. (159) Quereigh, 71, 20: 256; 14.
- (160) Raiteri, 22, 31 I: 112; 22. (160.1) Rankin and Wright, 12, 39: 1; 15. (161) Reed, 8, 65: 707; 98. (162) Reiner, 549, 12: 262; 13. (163) Reuter, 190, 1899 I: 155. (164) Rinne and Kolb, 190, 1910 II: 138. (165) Rjachina, 10, 4: 1026; 22. (166) Rösch, 94, 65: 680; 27. (167) Rose, 190B, 29: 53; 10. (168) Rose, 190, 1918: 1. (169) Rose, 96, 6: 165; 21.
- (170) Rosicky, 190, 1911 II: 21A. (171) Rudberg, 8, 17: 1; 1829. (172) Sabot, *Diss.*, Geneva, 1914. (173) Sarasin, 51, 2: 369; 83. (174) Schetelig, 94, 62: 567; 25. (175) Schlossmacher, 189, 1919: 106. (176) Schmidt, *Diss.*, Rostock, 1912. (177) Schrauf, 75, 41: 769; 60. (178) Schrauf, 75, 42: 107; 60. (179) Schrauf, 94, 18: 113; 91.
- (180) Schreiber, 190B, 37: 247; 14. (181) Schwarzmann, 190, 1897 I: 61. (182) Seouvert, 186, 1912: 97. (183) Seebach, 549, 11: 452; 12. (184) Sève, 51, 5: 249; 24. (184.1) Sieg, 48, 6: 448; 22. (185) Siliprandi, 508, 47: 61; 16. (186) Skinner, 2, 9: 148; 17. (187) Smith and Prior, 269, 14: 283; 07. (188) Spencer, 269, 19: 107; 20. (189) Starrabba, 508, 48: 52; 17.
- (190) Stevanović, 94, 37: 235; 03. (191) Stevanović, 94, 37: 257; 03. (192) Stranetzky, 481, 26: 143; 07. (193) Stuhlman, 94, 13: 339; 88. (194) Sundius, 94, 57: 212; 22. (195) Surgunoff, 94, 46: 220; 09. (196) Taubert, *Diss.*, Jena, 1905. 94, 44: 313; 08. (197) Terpstra, 94, 64: 150; 26. (198) Tietze, 190B, 12: 1; 99. (199) Tietze, 190, 1899 II: 87.
- (200) Topsøe and Christiansen, 8, *Erganz. Bd.*, 6: 499; 74. (201) Trolle, 63, 7: 700; 06. (202) Tsuboi, 269, 20: 93; 23. (203) Tutton, 4, 65: 628; 94. (204) Tutton, 4, 69: 344; 96. (205) Tutton, 4, 71: 846; 97. (206) Tutton, 94, 33: 1; 00. (207) Tutton, 94, 35: 529; 02. (208) Tutton, 94, 38: 602; 03. (209) Tutton, 94, 41: 321; 05.
- (210) Tutton, 94, 42: 529; 07. (211) Tutton, 94, 44: 113; 07. (212) Tutton, 94, 48: 190; 10. (213) Tutton, 94, 52: 433; 13. (214) Tutton, 62, 216: 1; 16. (215) Tutton, 62, 217: 199; 18. (216) Tutton, 62, 218: 395; 19. (217) Tutton, 5, 101: 225, 245; 22. (218) Tutton, 94, 58: 40; 23. (219) Tutton, 5, 108: 240; 25.
- (220) Tutton and Porter, 94, 51: 53; 12. (221) Tyndall, 2, 21: 162; 23. (222) Valasek, 2, 20: 639; 22. (222.1) van Dyke, 48, 6: 917; 22. (223) Viola, 481, 15: 135; 96. (224) Viola, 94, 30: 417; 99. (225) Viola, 94, 32: 305; 00. (226) Walter, 190B, 23: 581; 07. (226.1) Washington and Merwin, 328, 12: 233; 27. (227) Weber, 94, 57: 407; 22. (228) Weber, 189, 1909: 594. (229) Weigel, 188, 1915: 264, 299.
- (230) Weigel, 481, 38: 288; 25. (231) Wenzel, 190B, 41: 565; 17. (232) Werner, *Diss.*, Kiel, 1910. (233) Westphal, *Diss.*, Leipzig, 1913. (234) Wherry, 1, 40: 1852; 18. (235) Wherry, 1, 42: 125; 20. (235.1) Winchell, *Optical and microscopic characters of artificial minerals*. Madison, Univ. Wisconsin, 1927. (236.2) Wright, 12, 36: 509; 13. (237) Wülfing in Rosenbush, *Mikroskopische Physiographie der Mineralien und Gesteine*. Stuttgart, 1892. (238) Wülfing, 481, 15: 29, 49; 96. (239) Wülfing, 94, 25: 454; 96.
- (240) Wülfing, 94, 36: 538; 02. (241) Wulff, 94, 17: 592; 90. (242) Zambonini, *Mem. serv. descr. carta geol. Italia*, 7 II: 77; 19. (243) Zambonini, 94, 55: 292; 20. (244) Zambonini, 94, 57: 317; 22. (245) Zambonini, 94, 58: 226; 23. (245.1) Zambonini and Conoglio, 94, 67: R200; 28. (246) Zimányi, 94, 39: 505; 04. (247) Zimányi, 94, 40: 281; 05. (248) Aminoff, 207, 45: 124; 23. (249) Naeken, 189, 1912: 554.
- (250) Schröder, 94, 67: 485; 28. (251) Tutton, 5, 111: 462; 26. (252) Tutton, 5, 118: 367; 28. (253) Tutton, 5, 118: 393; 28. (254) Blittersdorf, 94, 71: 141; 29.

REFRACTIVITY OF PURE ORGANIC LIQUIDS

ALFRED L. DIXON AND CLARENCE J. WEST

(The numerical data for the following compounds, which were selected from the literature by Alfred L. Dixon and Dr. Roger Adams, were compiled by Clarence J. West.)

The following table gives values for the density and the refractive indices for the $H_{\alpha}(\alpha)$, $D(He)$ values are $*$), $H_{\beta}(\beta)$ and $H_{\gamma}(\gamma)$ lines for the more important carbon compounds. In the literature column, the citation from which the values were selected is followed by a \dagger . Values of wave-lengths represented by symbols are: H_{α} (α), 656.3m μ ; H_{β} (β), 486.15m μ ; H_{γ} (γ), 434.06m μ ; $D(Na)$, 589.3m μ ; He , 587.6m μ .

 \mathfrak{C} -Table; The \mathfrak{C} -Arrangement (v. Vol. III. p. viii) (Metallo-organic compounds at end of table)

Formula	Name	t , °C	d_4^t	α	D	β	γ	Lit.
CCl_3NO_2	Trichloronitromethane.....	22.8	1.6511	1.45793	1.46075	1.46785	1.47377	(106)
CCl_4	Carbon tetrachloride.....	12.3	1.6095	1.4599	1.4656	1.4726	1.4835	(132)
CN_4O_8	Tetranitromethane.....	16.9	1.6425	1.43628	1.43976*	1.44835	1.45593	(74)
CS_2	Carbon disulfide.....	18	1.2661	1.62011	1.62950	1.65439	1.67665	(111, \dagger 112, 132, 133, 134, 149, 153, 154)
$CHBr_3$	Bromoform.....	19.0	2.891	1.5875	1.5980	1.6107	1.6334	(132, \dagger 134)
$CHCl_3$	Chloroform.....	18	1.4844	1.44389	1.44643	1.45271	1.45779	(111, \dagger 112, 124, 132, 134, 149)
CH_2I_2	Methylene iodide.....	10.5	3.344	1.7275	1.7559	1.7750	1.8229(?)	(132)
CH_2O_2	Formic acid.....	20	1.2188	1.36927	1.37137	1.37643	1.38041	(147)
CH_3I	Methyl iodide.....	21.0	2.274	1.5185	1.5293	1.5423	1.5652	(132, \dagger 134)
CH_3NO	Formamide.....	22.7	1.1313	1.44292	1.44530	1.45426	1.46085	(106)
CH_3NO_2	Nitromethane.....	21.6	1.1354	1.37884	1.38133	1.38771	1.39305	(106)
$CH_4N_2O_2$	Methylnitroamine.....	48.6	1.2433	1.45722	1.46162	1.47211	1.48176	(109)
CH_4O	Methanol.....	14.50	0.7980	1.32948	1.33118	1.33490	1.33801	(122, 124, 148)
CH_5NO	β -Methylhydroxylamine.....	20.0	1.0003	1.41415	1.41638	1.42196	1.42639	(103, \dagger 106)
$C_2Br_4N_2$	Isoeyanotetrabromide.....	55.0	2.6796	1.63917	1.64650		1.68421	(109)
$C_2Cl_2O_2$	Oxalyl chloride.....	12.9	1.4888	1.43111	1.43395	1.44121	1.44743	(80)
C_2Cl_4	Perchloroethylene.....	20	1.6226	1.50153	1.50547	1.51522	1.52368	(92)
C_2HBr_3	Tribromoethylene.....	20	2.6876	1.59431	1.59919	1.61358	1.62548	(164)
C_2HCl_3O	Chloral.....	20	1.5121	1.45298	1.45572	1.46235	1.46786	(93)
C_2HCl_6	Pentachloroethane.....	24.0	1.6697	1.49946	1.50250	1.50984	1.51576	(141)
$C_2H_2Br_2$	Acetylene dibromide.....	20	2.2289	1.53898	1.54367	1.55548	1.56555	(164)
$C_2H_2Br_4$	1, 1, 1, 2-Tetrabromoethane.....	20	2.8748	1.62244	1.62772	1.64130	1.65290	(164)
$C_2H_2Br_4$	1, 1, 2, 2-Tetrabromoethane.....	20	2.9673	1.63263	1.63795	1.65114	1.66249	(164)
$C_2H_2Cl_4$	1, 1, 1, 2-Tetrachloroethane.....	23.2	1.5466	1.47880	1.48162	1.48847	1.49405	(141)
$C_2H_3Br_3$	1, 1, 2-Tribromoethane.....	20	2.5790	1.58444	1.58902	1.60064	1.61050	(164)
C_2H_3ClO	Acetyl chloride.....	20	1.1051	1.38736	1.38976	1.39543	1.40002	(80, 93 \dagger)
$C_2H_3Cl_3$	1, 1, 1-Trichloroethane.....	21.0	1.3345	1.43287	1.43765	1.44176	1.44961	(91)
$C_2H_3Cl_3$	1, 2, 2-Trichloroethane.....	22	1.4458	1.46927	1.47192	1.47862	1.48402	(141)
C_2H_3N	Acetonitrile.....	16.5	0.7863	1.34427	1.34596	1.35004	1.35333	(106)
C_2H_3NS	Methyl thiocyanate.....	23.8	1.0694	1.46509	1.46801	1.47624	1.48285	(158, 159)
$C_2H_3N_3$	1, 2, 5-Triazole.....	25.3	1.1861	1.48189	1.48544	1.49432	1.50168	(106)
$C_2H_4Br_2$	1, 1-Dibromoethane.....	20	2.0555	1.50900	1.51277	1.52215	1.53004	(164)
$C_2H_4Br_2$	1, 2-Dibromoethane.....	20	2.1768	1.53396	1.53789	1.54793	1.55624	(140, 164 \dagger)
$C_2H_4Cl_2$	1, 1-Dichloroethane.....	20	1.1743	1.41423	1.41655	1.42226	1.42671	(93, 164 \dagger)
$C_2H_4Cl_2$	1, 2-Dichloroethane.....	20	1.2521	1.44189	1.44432	1.45024	1.45528	(93, 140, 141, 164 \dagger)
C_2H_4O	Ethylene oxide.....	8.4	0.8896	1.35819	1.35988	1.36411	1.36759	(16)
$C_2H_4O_2$	Acetic acid.....	22.9	1.0446	1.36944	1.37152	1.37610	1.38003	(125, \dagger 147)
C_2H_5Br	Ethyl bromide.....	20	1.4555	1.42113	1.42386	1.43046	1.43595	(164)
C_2H_5I	Ethyl iodide.....	7.0	1.9671	1.5124	1.5222	1.5343	1.5551	(132, \dagger 134, 149)
C_2H_5NO	Acetaldoxime.....	20.4	0.9656	1.42290	1.42567	1.43270	1.43834	(106)
$C_2H_5NO_2$	Nitroethane.....	24.3	1.0472	1.38768	1.39007		1.40102	(106)
$C_2H_5NO_3$	Ethyl nitrate.....	21.5	1.1050	1.38254	1.38484		1.39511	(106)
$C_2H_5N_2O$	Nitrosodimethylamine.....	18.4	1.0049	1.43368	1.43743		1.45506	(106)
$C_2H_5N_2O_2$	Dimethylnitroamine.....	72.3	1.1090	1.44246	1.44622		1.46519	(109)
C_2H_5O	Ethyl alcohol.....	18.35	0.7917	1.36062	1.36242	1.36662	1.37011	(122, \dagger 133, 148, 149)
C_2H_5S	Ethylmercaptan.....	20	0.83907	1.42769	1.43055	1.43788	1.4445	(153, \dagger 154)
C_2H_7NO	β -Ethylhydroxylamine.....	63.9	0.9079	1.41381	1.41519		1.42463	(103, 106 \dagger)
$C_2H_8N_2$	<i>asym.</i> -Dimethylhydrazine.....	22.3	0.7914	1.40503	1.40753	1.41429	1.41990	(108, 109 \dagger)
$C_2H_8N_2$	Ethylenediamine.....	26.1	0.8919	1.45113	1.45400	1.46065	1.46624	(106)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ²⁰	α	D	β	γ	Lit.
C ₂ H ₁₀ N ₂ O	Ethylenediamine hydrate.....	20.5	0.9634	1.44732	1.44997	1.45630	1.46148	(106)
C ₃ H ₂ Cl ₂ O ₂	Malonyl chloride.....	22.1	1.4488	1.45866	1.46172	1.46904		(80)
C ₃ H ₂ N ₂	Malononitrile.....	34.2	1.0488	1.41259	1.41463		1.42371	(106)
C ₃ H ₃ NO	Isoxazole.....	16.6	1.0805	1.42685	1.42981*	1.43701	1.44321	(31)
C ₃ H ₄ N ₂	Pyrazole.....	99.8	1.0012	1.46633	1.47027*	1.47946	1.48666	(60)
C ₃ H ₄ O	Propargyl alcohol.....	20	0.9715	1.42796	1.43064	1.43734	1.44277	(92)
C ₃ H ₄ O	Acrolein.....	20	0.8410	1.39620	1.39975	1.40890	1.41691	(43,† 92)
C ₃ H ₄ O ₃	Pyrotartaric acid.....	15.3	1.2668	1.42768	1.43025		1.44110	(105)
C ₃ H ₅ Br	Allyl bromide.....	20	1.3980	1.46166	1.46545	1.47486	1.48297	(92)
C ₃ H ₅ Cl	Allyl chloride.....	20	0.9379	1.41245	1.41538	1.42248	1.42837	(95)
C ₃ H ₅ ClO	Epichlorohydrin.....	11.55	1.1927	1.43990	1.44195	1.44784	1.45264	(16,† 96)
C ₃ H ₅ ClO	Propionyl chloride.....	20	1.0646	1.40264	1.40507	1.41066	1.41541	(93)
C ₃ H ₅ N	Propionitrile.....	14.6	0.7872	1.36711	1.36888		1.37679	(106,† 132)
C ₃ H ₅ NO	Lactonitrile.....	18.4	0.9919	1.40374	1.40582		1.41454	(106)
C ₃ H ₆	Trimethylene.....	17.7	1.2105	1.43751	1.44021	1.44632	1.45131	(100)
C ₃ H ₆ ClNO	Dimethylchloroformamide.....	22.1	1.1657	1.44904	1.45196	1.45924	1.46538	(109)
C ₃ H ₆ I ₂	Trimethylene iodide.....	7.5	2.589	1.6347	1.6479	1.6643	1.6940	(132)
C ₃ H ₆ O	Allyl alcohol.....	20	0.8540	1.41051	1.41345	1.42004	1.42556	(92)
C ₃ H ₆ O	Propionaldehyde.....	20	0.8066	1.36157	1.36356	1.36825	1.37203	(92)
C ₃ H ₆ O	Acetone.....	19.4	0.79115	1.35672	1.35886	1.36366	1.36750	(125,† 134)
C ₃ H ₆ O ₂	Propionic acid.....	19.9	0.98706	1.38535	1.38736	1.39220	1.39596	(125,† 147)
C ₃ H ₆ O ₂	Ethyl formate.....	20	0.91678	1.35789	1.35975	1.36416	1.36762	(125,† 134)
C ₃ H ₆ O ₂	Methyl acetate.....	20	0.92438	1.35745	1.35935	1.36357	1.36707	(125)
C ₃ H ₇ Br	Isopropyl bromide.....	20	1.3097	1.42230	1.42508	1.43165	1.43709	(93)
C ₃ H ₇ Br	<i>n</i> -Propyl bromide.....	20	1.3529	1.43142	1.43414	1.44064	1.44625	(93)
C ₃ H ₇ Cl	<i>n</i> -Propyl chloride.....	20	0.8898	1.38659	1.38856	1.39344	1.39747	(92)
C ₃ H ₇ Cl ₂ N	Propyldichloroamine.....	23	1.1454	1.44940	1.45248		1.46595	(106)
C ₃ H ₇ I	Isopropyl iodide.....	20	1.7033	1.49519	1.49969	1.51080	1.52026	(93)
C ₃ H ₇ I	<i>n</i> -Propyl iodide.....	20	1.7427	1.50082	1.50508	1.51566	1.52467	(93)
C ₃ H ₇ N	Allylamine.....	21.8	0.7613	1.41645	1.41943	1.42686	1.43307	(106)
C ₃ H ₇ NO	Dimethylformamide.....	22.4	0.9484	1.42649	1.42938	1.43651	1.44254	(109)
C ₃ H ₇ NO ₂	Nitropropane.....	24.3	1.0081	1.39787	1.40027		1.41104	(106)
C ₃ H ₈ N ₂ O ₂	Ethylmethylnitroamine.....	19.2	1.0972	1.45326	1.45711	1.46668	1.47536	(109)
C ₃ H ₈ O	Isopropyl alcohol.....	20	0.7887	1.37569	1.37757	1.38210	1.38572	(93)
C ₃ H ₈ O	<i>n</i> -Propyl alcohol.....	20	0.8044	1.38345	1.38543	1.39008	1.39378	(92,† 148)
C ₃ H ₈ O ₂	Methylal.....	20	0.8604	1.35183	1.35344	1.35763	1.36085	(28, 93,† 108, 112)
C ₃ H ₉ N	<i>n</i> -Propylamine.....	16.6	0.7209	1.38793	1.39006	1.39532	1.39956	(106,† 132)
C ₃ H ₉ N	Isopropylamine.....	15.4	0.6935	1.37488	1.37698		1.38620	(106)
C ₄ N ₂	Acetylene dicyanide.....	25	0.9703	1.46021	1.46471	1.47610	1.48593	(151)
C ₄ HCl ₃ O ₂	<i>asym.</i> -Chloromaleyl chloride.....	18.1	1.6049	1.50948	1.51362	1.52356	1.53229	(80)
C ₄ HCl ₃ O ₂	Chlorofumaryl chloride.....	17.6	1.5662	1.51663	1.52172	1.53447	1.54625	(80)
C ₄ H ₂ Br ₂ S	α , α' -Dibromothiophene.....	13.8	2.1531	1.62643	1.63315*	1.64989	1.66504	(59)
C ₄ H ₂ Cl ₂ O ₂	Fumaryl chloride.....	18.1	1.4103	1.49592	1.50038	1.51274	1.52360	(80)
C ₄ H ₂ Cl ₃ N	γ , γ , γ -Trichlorocrotonitrile.....	11.2	1.4319	1.50837	1.51225	1.52242	1.53138	(86)
C ₄ H ₂ Cl ₄ O	Trichlorocrotonyl chloride.....	18.8	1.5292	1.51414	1.51812	1.52890	1.53823	(86)
C ₄ H ₃ BrS	α -Bromothiophene.....	15.8	1.6900	1.58350	1.58927*	1.60365	1.61644	(59)
C ₄ H ₃ ClS	α -Chlorothiophene.....	14.2	1.2838	1.54556	1.55068*	1.56333	1.57458	(59)
C ₄ H ₃ Cl ₂ N	γ , γ -Dichlorocrotonitrile.....	20	1.3049	1.49369	1.49735	1.50714	1.51500	(86)
C ₄ H ₃ Cl ₃ O	γ , γ -Dichlorocrotonyl chloride.....	19.6	1.4429	1.49547	1.49928	1.50818	1.51674	(86)
C ₄ H ₄ Cl ₂ O ₂	Succinyl chloride.....	15.2	1.3948	1.47042	1.47348	1.48076	1.48702	(80)
C ₄ H ₄ Cl ₂ O ₂	γ , γ -Dichlorocrotonic acid.....	99.4	1.3327	1.45680	1.45966	1.46777	1.47565	(86)
C ₄ H ₄ N ₂	Ethylene dicyanide.....	63.1	0.9848	1.41432	1.41645		1.42543	(106)
C ₄ H ₄ N ₂	Pyrazine.....	60.9	1.0311	1.49037	1.49526		1.52040	(109)
C ₄ H ₄ N ₂	Pyridazine.....	23.5	1.1035	1.51842	1.52311	1.53541	1.54641	(109)
C ₄ H ₄ O	Furfurane.....	20	0.9366	1.41837	1.42157	1.42967	1.43668	(41)
C ₄ H ₄ O ₃	γ -Hydroxy- Δ^2 -crotonolactone.....	99.3	1.2621	1.45349	1.45632	1.46464		(86)
C ₄ H ₄ S	α -Thiophene.....	16.8	1.0674	1.52570	1.53072*	1.54309	1.55392	(59,† 109, 144, 157, 158, 159)
C ₄ H ₅ BrN ₂	3-Methyl-4-bromopyrazole.....	99.6	1.5638	1.51402	1.51823*	1.52820	1.53677	(60)
C ₄ H ₅ BrO	α -Bromocrotonaldehyde.....	13.3	1.5797	1.51682	1.52142	1.53460	1.54578	(53)
C ₄ H ₅ ClO	Crotonyl chloride.....	17.9	1.0818	1.45594	1.46001	1.47060	1.47993	(80)
C ₄ H ₅ Cl ₃ O	γ , γ , γ -Trichlorobutyraldehyde.....	20	1.3956	1.47259	1.47554	1.48198	1.48736	(93)
C ₄ H ₅ Cl ₃ O	Ethyl trichloroacetate.....	20	1.3826	1.44802	1.45068	1.45673	1.46176	(93)

Formula	Name	$t, ^\circ\text{C}$	d_4^t	α	D	β	γ	Lit.
$\text{C}_4\text{H}_5\text{N}$	Crotononitrile.....	18.9	0.8225	1.41310	1.41607	1.42405	1.43080	(58)
$\text{C}_4\text{H}_5\text{N}$	Pyrrrole.....	13.9	0.9613	1.50399	1.50851*	1.51955	1.52908	(60,† 106)
$\text{C}_4\text{H}_5\text{NO}$	α -Methylisoxazole.....	16.7	1.0259	1.43775	1.44087*	1.44826	1.45484	(31)
$\text{C}_4\text{H}_5\text{NO}$	γ -Methylisoxazole.....	18.15	1.0238	1.43296	1.43590*	1.44279	1.44882	(31)
$\text{C}_4\text{H}_6\text{Br}_2$	Dimethylacetylene dibromide.....	25.45	1.3180	1.45280	1.45616	1.46430	1.47115	(107)
$\text{C}_4\text{H}_6\text{Cl}_2\text{O}$	β -Chlorobutyryl chloride.....	20.05	1.2165	1.44833	1.45085	1.45774	1.46341	(66)
$\text{C}_4\text{H}_6\text{Cl}_2\text{O}_2$	Ethyl dichloroacetate.....	20	1.2821	1.43615	1.43860	1.44435	1.44894	(93)
$\text{C}_4\text{H}_6\text{N}_2$	3-Methylpyrazole.....	16.3	1.0203	1.49330	1.49717*	1.50656	1.51465	(60)
$\text{C}_4\text{H}_6\text{N}_2$	<i>C</i> -Methylpyrazole.....	13.7	1.0227	1.49042	1.49412	1.50362	1.51157	(157)
$\text{C}_4\text{H}_6\text{N}_2\text{O}$	Dimethylfurazane.....	18.9	1.0495	1.42477	1.42713	1.43316	1.43816	(109)
$\text{C}_4\text{H}_6\text{N}_2\text{O}_2$	Ethyl diazoacetate.....	17.6	1.0852	1.45447	1.45876	1.47017	1.47994	(106)
$\text{C}_4\text{H}_6\text{O}$	Crotonaldehyde.....	17.3	0.8557	1.43415	1.43838	1.44908	1.45852	(43,† 44)
$\text{C}_4\text{H}_6\text{O}_2$	Trimethylenecarboxylic acid.....	17.1	1.0907	1.43488	1.43754	1.44363	1.44856	(110)
$\text{C}_4\text{H}_6\text{O}_2$	Methacrylic acid.....	20	1.0153	1.42815	1.43143	1.43959	1.44635	(92, 94)
$\text{C}_4\text{H}_6\text{O}_2$	Isocrotonic acid.....	19.6	1.0261	1.44203	1.44579*	1.45495	1.46276	(69)
$\text{C}_4\text{H}_6\text{O}_2$	Diacetyl.....	18.5	0.9808	1.39105	1.39331	1.39897	1.40317	(18, 105†)
$\text{C}_4\text{H}_7\text{Br}$	2-Bromo-2-butene.....	25.35	1.3216	1.45490	1.45828	1.46637	1.47337	(107)
$\text{C}_4\text{H}_7\text{ClO}$	Butyryl chloride.....	20	1.0277	1.40971	1.41209	1.41781	1.42249	(93)
$\text{C}_4\text{H}_7\text{ClO}_2$	β -Chlorobutyric acid.....	19.85	1.1865	1.43992	1.44213	1.44828	1.45327	(66)
$\text{C}_4\text{H}_7\text{ClO}_2$	Ethyl chloroacetate.....	20	1.1585	1.42056	1.42274	1.42812	1.43228	(93)
$\text{C}_4\text{H}_8\text{N}_2\text{O}_3$	Nitrosomethylurethane.....	19.0	1.1402	1.43566	1.43905	1.44807		(118)
$\text{C}_4\text{H}_8\text{N}_2\text{O}_4$	Ethyl methylnitrocarbamate.....	23.0	1.2288	1.44507	1.44826	1.45628	1.46330	(109)
$\text{C}_4\text{H}_8\text{O}$	<i>n</i> -Butyraldehyde.....	20	0.8170	1.38222	1.38433	1.38932	1.39321	(93)
$\text{C}_4\text{H}_8\text{O}$	Isobutyraldehyde.....	20	0.7938	1.37094	1.37302	1.37769	1.38170	(93)
$\text{C}_4\text{H}_8\text{O}$	Methyl ethyl ketone.....	15.9	0.8087	1.37844	1.38071	1.38554	1.38938	(125)
$\text{C}_4\text{H}_8\text{O}_2$	<i>n</i> -Butyric acid.....	20.3		1.39582	1.39777	1.40271	1.40685	(131,† 147)
$\text{C}_4\text{H}_8\text{O}_2$	Isobutyric acid.....	20	0.9490	1.39093	1.39300	1.39722	1.40166	(92, 94)
$\text{C}_4\text{H}_8\text{O}_2$	Ethyl acetate.....	18.9	0.89464	1.37023	1.37216	1.37662	1.38022	(125,† 134, 149)
$\text{C}_4\text{H}_8\text{O}_2$	Methyl propionate.....	18.5	0.91662	1.37570	1.37767	1.38218	1.38596	(125)
$\text{C}_4\text{H}_8\text{O}_2$	Diethylene dioxide.....	16.8	1.0366	1.42003	1.42218*	1.42720	1.43146	(1)
$\text{C}_4\text{H}_9\text{Cl}_2\text{N}$	Isobutyldichloroamine.....	24.0	1.0895	1.44544	1.44843	1.45577	1.46150	(106)
$\text{C}_4\text{H}_9\text{I}$	<i>n</i> -Butyl iodide.....	20	1.6166	1.49601	1.50006	1.51005	1.51844	(93)
$\text{C}_4\text{H}_9\text{I}$	Isobutyl iodide.....	20	1.6056	1.49192	1.49597	1.50566	1.51398	(93,† 132)
$\text{C}_4\text{H}_9\text{NO}$	Acetimidoethyl ether.....	18.8	0.8729	1.40122	1.40348	1.40887	1.41326	(109)
$\text{C}_4\text{H}_9\text{NO}$	Dimethylacetamide.....	22.5	0.9409	1.43436	1.43708	1.44398	1.44976	(109)
$\text{C}_4\text{H}_9\text{NO}$	Isobutyraldoxime.....	20.5	0.9015	1.42752	1.43022		1.44243	(106)
$\text{C}_4\text{H}_9\text{NO}_2$	Isobutyl nitrite.....	22.1	0.8699	1.36932	1.37151	1.37708	1.38196	(106)
$\text{C}_4\text{H}_9\text{NO}_3$	Isobutyl nitrate.....	23.3	1.0112	1.39904	1.40130	1.40699	1.41171	(106)
$\text{C}_4\text{H}_{10}\text{N}_2\text{O}$	Nitrosodiethylamine.....	19.9	0.9431	1.43535	1.43864		1.45422	(106)
$\text{C}_4\text{H}_{10}\text{N}_2\text{O}_2$	<i>n</i> -Butylnitroamine.....	23.0	1.0579	1.45680	1.46039	1.46906	1.47665	(109)
$\text{C}_4\text{H}_{10}\text{N}_2\text{O}_2$	<i>sec</i> -Butylnitroamine.....	21.9	1.0566	1.45457	1.45810	1.46648	1.47395	(109)
$\text{C}_4\text{H}_{10}\text{O}$	<i>n</i> -Butyl alcohol.....	20	0.8099	1.39712	1.39909	1.40395	1.40773	(93)
$\text{C}_4\text{H}_{10}\text{O}$	Isobutyl alcohol.....	17.5	0.8046	1.3948	1.3968	1.4016	1.4055	(148)
$\text{C}_4\text{H}_{10}\text{O}$	Trimethyl carbinol.....	20	0.7864	1.38572	1.38779	1.39243	1.39618	(93)
$\text{C}_4\text{H}_{10}\text{O}$	Ethyl ether.....	17.1	0.7183	1.35246	1.35424	1.35854	1.36189	(108,† 133, 134, 149)
$\text{C}_4\text{H}_{10}\text{O}_3\text{S}$	Ethyl ethylsulfonate.....	22	1.1452	1.41733	1.41959	1.42420	1.42864	(153, 154)
$\text{C}_4\text{H}_{10}\text{S}$	Ethyl sulfide.....	20.5	0.8362	1.43970	1.44253	1.44960	1.45543	(109,† 153, 154)
$\text{C}_4\text{H}_{10}\text{S}$	Isobutylmercaptan.....	20	0.8357	1.43575	1.43859	1.44547	1.4511	(153, 154)
$\text{C}_4\text{H}_{10}\text{S}_2$	Ethyl disulfide.....	20	0.99267	1.50306	1.50633	1.51604	1.52407	(153, 154)
$\text{C}_4\text{H}_{11}\text{N}$	Diethylamine.....	17.6	0.7108	1.38510	1.38730	1.39264	1.39703	(106)
$\text{C}_4\text{H}_{11}\text{N}$	<i>sec</i> -Butylamine.....	16.7	0.7271	1.39280	1.39501		1.40453	(106)
$\text{C}_4\text{H}_{11}\text{N}$	Isobutylamine.....	17.0	0.7359	1.39664	1.39878		1.40829	(106)
$\text{C}_4\text{H}_{11}\text{N}$	<i>tert</i> -Butylamine.....	18.0	0.6978	1.37740	1.37940	1.38440	1.38868	(109)
$\text{C}_4\text{H}_{11}\text{O}_3\text{P}$	Diethylphosphorous acid.....	10	1.0757	1.40624	1.40823	1.41300	1.41699	(2)
$\text{C}_5\text{H}_4\text{O}_2$	Coumalin.....	19.45	1.1984	1.52377	1.53005	1.54859	1.56674	(23)
$\text{C}_5\text{H}_4\text{O}_2$	Furfural.....	20	1.1594	1.51862	1.52608	1.54566	1.56484	(95)
$\text{C}_5\text{H}_4\text{O}_3$	Citraconic anhydride.....	20	1.2542	1.46774	1.47166	1.48154	1.49026	(45†, 144)
$\text{C}_5\text{H}_5\text{Cl}_3\text{O}_2$	Methyl γ, γ, γ -trichlorocrotonate.....	21.2	1.3970	1.48621	1.48975	1.49883	1.50635	(81)
$\text{C}_5\text{H}_5\text{N}$	Pyridine.....	21	0.9808	1.50456	1.50919	1.52118	1.53153	(106,† 134, 145, 157)
$\text{C}_5\text{H}_6\text{Cl}_2\text{O}_2$	3, 3, Dichloroacetylacetone.....	16.75	1.3067	1.45648	1.45885	1.46547	1.47109	(34)
$\text{C}_5\text{H}_6\text{Cl}_2\text{O}_2$	α, δ -Dichloro- γ -valerolactone.....	24.6	1.4363	1.49367	1.49624	1.50286	1.50838	(80)
$\text{C}_5\text{H}_6\text{Cl}_2\text{O}_2$	Methyl γ, γ -dichlorocrotonate.....	17.7	1.3050	1.46744	1.47040	1.47811	1.48442	(86)
$\text{C}_5\text{H}_6\text{Cl}_2\text{O}_2$	Glutaryl chloride.....	20.2	1.3239	1.47004	1.47281	1.47989	1.48576	(80)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ^t	α	D	β	γ	Lit.
C ₅ H ₆ N ₂	Methylpyrazine.....	18.7	1.0302	1.50170	1.50666		1.53164	(109)
C ₅ H ₆ N ₂	Trimethylene dicyanide.....	23.2	0.9888	1.4318	1.4365	1.4420	1.4514	(132)
C ₅ H ₆ N ₂ O ₃	Methyl methylloximinocynoacetate....	20	1.1768	1.4551	1.4591	1.4693	1.4788	(152)
C ₅ H ₆ O ₂	α-Angelolactone.....	13.2	1.0904	1.44776	1.45064*	1.45771	1.46381	(28)
C ₅ H ₆ O ₂	β-Angelolactone.....	15.2	1.0783	1.45936	1.46268*	1.47092	1.47813	(28)
C ₅ H ₆ O ₂	Propargyl acetate.....	20	1.0052	1.41796	1.42047	1.42659	1.43163	(92)
C ₅ H ₆ S	α-Thiotolene.....	15.3	1.0231	1.51919	1.52388*	1.53555	1.54586	(59)
C ₅ H ₆ S	β-Thiotolene.....	14.8	1.0268	1.51910	1.52380*	1.53538	1.54564	(59)
C ₅ H ₇ BrN ₂	1, 3-Dimethyl-4-bromopyrazole.....	14.7	1.4976	1.51652	1.52137*	1.53078	1.54056	(38)
C ₅ H ₇ Br ₂ N	α, β-Dibromovaleronitrile.....	17.6	1.7598	1.51766	1.52133*	1.53019	1.53881	(69)
C ₅ H ₇ ClN ₂	1, 3-Dimethyl-4-chloropyrazole.....	17.1	1.1604	1.49102	1.49462*	1.50327	1.51115	(38)
C ₅ H ₇ ClN ₂	1, 5-Dimethyl-4-chloropyrazole.....	17.7	1.1686	1.49349	1.49725*	1.50592	1.51335	(38)
C ₅ H ₇ ClO	β, β-Dimethylacryl chloride.....	12.35	1.0652	1.47479	1.47980*	1.49137	1.50231	(69)
C ₅ H ₇ ClO	α, β-Pentenyl chloride.....	18.0	1.0653	1.46225	1.46616*	1.47597	1.48481	(69)
C ₅ H ₇ ClO	β, γ-Pentenyl chloride.....	16.9	1.0666	1.41716	1.44990*	1.45733	1.46383	(69)
C ₅ H ₇ ClO ₂	3-Chloroacetylacetone.....	16.7	1.1686	1.47485	1.47976	1.49389		(34)
C ₅ H ₇ ClO ₂	Methyl α-chlorocrotonate.....	22.6	1.1587	1.45302	1.45634	1.46477	1.47187	(126)
C ₅ H ₇ N	N-Methylpyrrole.....	16.0	0.9106	1.48454	1.48890*	1.49945	1.50859	(60)
C ₅ H ₇ N	α, β-Pentenonitrile.....	15.5	0.8311	1.43134	1.43472*	1.44308	1.44988	(69)
C ₅ H ₇ N	β, γ-Pentenonitrile.....	18.8	0.8423	1.42084	1.42358*	1.42998	1.43547	(58, 69†)
C ₅ H ₇ NO	α, γ-Dimethylisoxazole.....	16.7	0.9864	1.44102	1.44393*	1.45115	1.45736	(31)
C ₅ H ₇ NO ₂	Ethyl cyanoacetate.....	20.5	1.0629	1.41584	1.41793	1.42312	1.42730	(106)
C ₅ H ₈	Cyclopentene.....	7.1	0.7861	1.42818	1.43052	1.43746	1.44306	(16)
C ₅ H ₈	1, 1-Dimethylallene.....	3.3	0.6915	1.41396	1.41722	1.42664	1.43450	(18)
C ₅ H ₈	Valerylene.....	20	0.6786	1.39763	1.40044	1.40726	1.41304	(92)
C ₅ H ₈ Cl ₂ O ₂	Ethyl dichloropropionate.....	20	1.2461	1.44553	1.44815	1.45379	1.45854	(93)
C ₅ H ₈ N ₂	1, 3-Dimethylpyrazole.....	15.2	0.9628	1.46769	1.47118*	1.47959	1.48686	(60)
C ₅ H ₈ N ₂ O	Ethylmethylfurazan.....	18.8	1.0180	1.43022	1.43257	1.43861	1.44356	(109)
C ₅ H ₈ O	Cyclopentanone.....	17.3	0.9513	1.43587	1.43817	1.44390	1.44867	(55)
C ₅ H ₈ O	Ethylideneacetone.....	19.6	0.8577	1.43536	1.43903	1.44846	1.45680	(43)
C ₅ H ₈ O	Propargyl ethyl ether.....	20	0.8326	1.40152	1.40390	1.40961	1.41439	(92)
C ₅ H ₈ O ₂	Acetylacetone.....	18.5	0.9771	1.44696	1.45178	1.46450	1.47758	(17, † 56, 105, 131)
C ₅ H ₈ O ₂	Acetylpropionyl.....	19.0	0.9565	1.39918	1.40135		1.41134	(105)
C ₅ H ₈ O ₂	Angelic acid.....	100	0.9295	1.41674	1.41998*	1.42846	1.43593	(69)
C ₅ H ₈ O ₂	Cyclobutanecarboxylic acid.....	16.6	1.0570	1.44151	1.44393	1.44976	1.45453	(110, † 130)
C ₅ H ₈ O ₂	α, β-Pentenic acid.....	14.7	0.9947	1.44977	1.45370*	1.46269	1.47068	(69)
C ₅ H ₈ O ₂	β, γ-Pentenic acid.....	18.8	0.9885	1.43285	1.43569*	1.44248	1.44821	(69)
C ₅ H ₈ O ₂	Tiglic acid.....	99.7	0.9425	1.42435	1.42746*	1.43629	1.44407	(69)
C ₅ H ₈ O ₂	Allyl acetate.....	20	0.9276	1.40205	1.40448	1.41059	1.41561	(92)
C ₅ H ₈ O ₃	Levulinic acid.....	15.8	1.1449	1.43941	1.44217	1.44765	1.45267	(49, † 105)
C ₅ H ₈ O ₃	Ethyl pyruvate.....	15.6	1.0596	1.40606	1.40830	1.41361	1.41825	(6)
C ₅ H ₈ O ₃	Methyl acetoacetate.....	20.5	1.0756	1.41616	1.41837	1.42418	1.42906	(9, † 105)
C ₅ H ₈ O ₃	Methyl α-methoxyacrylate.....	18.95	1.0702	1.42911	1.43207	1.43960	1.44614	(5)
C ₅ H ₈ O ₄	Dimethyl malonate.....	17.3	1.1571	1.41284	1.41490	1.41791	1.42420	(105)
C ₅ H ₉ ClO	Isovaleryl chloride.....	24.3	0.9854	1.41116	1.41361	1.41933	1.42391	(80)
C ₅ H ₉ ClO	Valeryl chloride.....	20	0.9887	1.41318	1.41555	1.42131	1.42599	(93)
C ₅ H ₉ ClO ₂	Ethyl α-chloropropionate.....	20	1.0869	1.41623	1.41850	1.42370	1.42805	(93)
C ₅ H ₁₀	Amylene.....	20	0.6476	1.37330	1.37576	1.38127	1.38588	(92, † 134, 148)
C ₅ H ₁₀	2-Pentene.....	14.7	0.6574	1.38141	1.38354	1.38998	1.39530	(16)
C ₅ H ₁₀ Br ₂	Amylene bromide.....	15	1.6700	1.5060	1.5094	1.5178	1.5240	(140)
C ₅ H ₁₀ N ₂ O	Nitrosopiperidine.....	18.5	1.0631	1.48940	1.49328		1.51197	(106)
C ₅ H ₁₀ N ₂ O ₂	Nitropiperidine.....	26.4	1.1519	1.49152	1.49540	1.50526	1.51392	(109)
C ₅ H ₁₀ N ₂ O ₃	Nitrosoethylurethane.....	16.9	1.0885	1.43354	1.43676	1.44530		(118, 119)
C ₅ H ₁₀ O	Cyclopentanol.....	13.5	0.9533	1.45387	1.45600	1.46169	1.46649	(16)
C ₅ H ₁₀ O	Allyl ethyl ether.....	20	0.7651	1.38565	1.38810	1.39387	1.39874	(92)
C ₅ H ₁₀ O	Diethyl ketone.....	16.6	0.8175	1.39168	1.39385	1.39877	1.40298	(105, 125†)
C ₅ H ₁₀ O	Methyl isopropyl ketone.....	16	0.8046	1.38569	1.38788	1.39268	1.39687	(125)
C ₅ H ₁₀ O	Methyl propyl ketone.....	20.2	0.8089	1.38754	1.38946	1.39461	1.39881	(125)
C ₅ H ₁₀ O ₂	Cyclo-γ-hydroxyvaleric aldehyde.....	17.6	1.0216	1.43365	1.43606*	1.44100	1.44532	(28)
C ₅ H ₁₀ O ₂	Isovaleric acid.....	22.4	0.95592	1.39964	1.40178	1.40677	1.41107	(125, † 147)
C ₅ H ₁₀ O ₂	Ethyl propionate.....	20.2	0.88886	1.38193	1.38385	1.38849	1.39225	(125, † 134)
C ₅ H ₁₀ O ₂	Isobutyl formate.....	19.9	0.88182	1.38386	1.38584	1.39063	1.39469	(125)
C ₅ H ₁₀ O ₂	Propyl acetate.....	20	0.8865	1.38235	1.38438	1.38903	1.39274	(92)

Formula	Name	t , °C	d_4^t	α	D	β	γ	Lit.
C ₅ H ₁₀ O ₃	Diethyl carbonate.....	20	0.9762	1.38335	1.38523	1.38969	1.39321	(28, 93, † 134)
C ₅ H ₁₁ Br	Amyl bromide.....	12.8	1.2214	1.4427	1.4450	1.4517	1.4570	(140)
C ₅ H ₁₁ Cl	Amyl chloride.....	18.2	0.8720	1.4076	1.4097	1.4150	1.4192	(140)
C ₅ H ₁₁ Cl	<i>tert.</i> -Amyl chloride.....	13.5	0.8699	1.4054	1.4082	1.4138	1.4181	(140)
C ₅ H ₁₁ Cl ₂ N	Isoamylchloroamine.....	25.7	1.0273	1.44110	1.44381		1.45611	(106)
C ₅ H ₁₁ N	Piperidine.....	18.7	0.8628	1.45097	1.45350	1.45989	1.46512	(106, † 157)
C ₅ H ₁₁ NO	Diethyl ketoxime.....	24.1	0.9083	1.44080	1.44350		1.45550	(106)
C ₅ H ₁₁ NO	Isovaleraldoxime.....	22.1	0.8897	1.43382	1.43645		1.44830	(106)
C ₅ H ₁₁ NO	Propionimido ethyl ether.....	16.9	0.8707	1.40806	1.41028	1.41571	1.42025	(109)
C ₅ H ₁₁ NO ₂	Diethyl imidocarbonate.....	18.2	0.9637	1.41472	1.41704	1.42235	1.42674	(109)
C ₅ H ₁₁ NO ₂	Isoamyl nitrite.....	20.7	0.8717	1.38486	1.38708		1.39761	(106)
C ₅ H ₁₁ NO ₂	Nitroisopentane.....	20.6	0.9599	1.41570	1.41806		1.42908	(106)
C ₅ H ₁₁ NO ₃	Isoamyl nitrate.....	21.7	0.9961	1.40987	1.41219		1.42261	(106)
C ₅ H ₁₂	Pentane.....	15.7	0.6251	1.3581	1.3570	1.3610	1.3645	(148)
C ₅ H ₁₂ N ₂ O ₂	<i>n</i> -Butylmethylnitroamine.....	23.6	1.0232	1.45282	1.45631	1.46494	1.47250	(109)
C ₅ H ₁₂ N ₂ O ₂	Isobutylmethylnitroamine.....	22.5	1.0211	1.45258	1.45607	1.46473	1.47228	(109)
C ₅ H ₁₂ O	Amyl alcohol.....	14.60	0.8142	1.40747	1.40963	1.41452	1.41870	(93, 122, † 148)
C ₅ H ₁₂ O	Isoamyl alcohol.....	17.8	0.8134	1.4064	1.4084	1.4135	1.4176	(148)
C ₅ H ₁₂ O	Propyl ethyl ether.....	20	0.7386	1.36758	1.36948	1.37397	1.37765	(92)
C ₅ H ₁₂ S	Isoamylmercaptan.....	20	0.83475	1.43824	1.44118	1.44734	1.45308	(153, 154)
C ₅ H ₁₃ N	Isoamylamine.....	17.9	0.7514	1.40739	1.40959		1.41920	(106)
C ₅ H ₁₃ N	Methyl- <i>n</i> -butylamine.....	18.1	0.7363	1.39950	1.40180	1.40708	1.41145	(108, 109†)
C ₅ H ₁₄ N ₂	<i>asym.</i> -Methyl- <i>n</i> -butylhydrazine.....	21.3	0.8040	1.42330	1.42586	1.43196	1.43703	(108, 109†)
C ₆ H ₃ Cl ₃	Trichlorobenzene.....	20	1.5563	1.5809	1.5671	1.5602	1.5945	(134)
C ₆ H ₄ BrNO ₂	<i>m</i> -Bromonitrobenzene.....	20.1	1.7036	1.59084	1.59791	1.61705	1.63429	(109)
C ₆ H ₄ Br ₂	<i>m</i> -Dibromobenzene.....	18.7	1.9561	1.60303	1.60879	1.62469	1.63829	(47)
C ₆ H ₄ Br ₂	<i>p</i> -Dibromobenzene.....	99.3	1.8201	1.56897	1.57425	1.58939		(47)
C ₆ H ₄ Cl ₂	<i>o</i> -Dichlorobenzene.....	20.4	1.2979	1.54384	1.54848	1.56141	1.57289	(47)
C ₆ H ₄ Cl ₂	<i>m</i> -Dichlorobenzene.....	20.9	1.2879	1.54111	1.54570	1.55887	1.56989	(47)
C ₆ H ₄ Cl ₂	<i>p</i> -Dichlorobenzene.....	80.3	1.2189	1.51673	1.52104	1.53388	1.54455	(47)
C ₆ H ₅ Br	Bromobenzene.....	20	1.4914	1.55439	1.55977	1.57362	1.58557	(47, 92, † 135, 140)
C ₆ H ₅ Cl	Chlorobenzene.....	20	1.1066	1.51986	1.52479	1.53693	1.54750	(47, 92, † 135, 140)
C ₆ H ₅ F	Fluorobenzene.....	22.8	1.0207	1.4563	1.4646	1.4751	1.4849	(135)
C ₆ H ₅ I	Iodobenzene.....	18.5	1.8324	1.61438	1.62145	1.63964	1.65520	(47, † 135)
C ₆ H ₅ NO	Pyridine-2-aldehyde.....	18.5	1.1255	1.53284	1.53886	1.55396	1.56749	(139)
C ₆ H ₅ NO ₂	Nitrobenzene.....	20	1.2039	1.54593	1.55291	1.57124		(91, 92, 106, † 134)
C ₆ H ₅ N ₃	Diazobenzencimide.....	22.5	1.0776	1.55760	1.56421	1.58181	1.59757	(106, † 161)
C ₆ H ₆	Benzene.....	20	0.8791	1.49663	1.50144	1.51327	1.52361	(20, 92, 132, 134, 144, 148, 162, 164†)
C ₆ H ₆	Dipropargyl.....	23.8	0.8008	1.43795	1.44132	1.45014	1.45774	(101)
C ₆ H ₆ BrN	<i>m</i> -Bromoaniline.....	20.4	1.5793	1.61900	1.62604	1.64550	1.66286	(106)
C ₆ H ₆ ClN	<i>m</i> -Chloroaniline.....	20.7	1.2142	1.58753	1.59424		1.62794	(106)
C ₆ H ₆ O	Phenol.....	40.6	1.0596	1.53691	1.54247	1.55581	1.56840	(126, † 133)
C ₆ H ₆ OS	α -Acetothienone.....	21.8	1.1679	1.55940	1.56630*	1.58441	1.60177	(59)
C ₆ H ₆ S	Thiophenol.....	23.2	1.0739	1.57971	1.58613	1.60285	1.61685	(126)
C ₆ H ₇ ClO	Sorbyl chloride.....	18.75	1.0666	1.54707	1.55710*	1.58453		(27)
C ₆ H ₇ Cl ₃ O ₂	Ethyl γ , γ , γ -trichloroerotonate.....	14.2	1.3375	1.48360	1.48693	1.49562	1.50303	(81)
C ₆ H ₇ N	Aniline.....	20	1.0216	1.57948	1.58629	1.60434	1.62074	(92, 106, † 132, 134, 144, 164)
C ₆ H ₇ N	α -Methylpyridine.....	16.7	0.9484	1.49844	1.50293	1.51444	1.52441	(106)
C ₆ H ₇ N	β -Methylpyridine.....	24.0	0.9539	1.49963	1.50432		1.52571	(106)
C ₆ H ₈	Dihydrobenzene.....	21.2	0.8466	1.46921	1.47296	1.48258	1.49092	(104)
C ₆ H ₈	1, 3, 5-Hexatriene.....	16.2	0.74067	1.47819		1.50272	1.51958	(45)
C ₆ H ₈ Br ₂ Cl ₂ O ₂	Ethyl α , β -dibromo- γ , γ -dichlorobutyrate.....	22.6	1.8257	1.51936	1.52233	1.53096	1.53787	(86)
C ₆ H ₈ Cl ₂ O ₂	Ethyl γ , γ -dichloroerotonate.....	16.6	1.2323	1.46096	1.46347	1.47098	1.47711	(86)
C ₆ H ₈ N ₂	2, 5-Dimethylpyrazine.....	23.6	0.9856	1.49457	1.49921	1.51202	1.52372	(106)
C ₆ H ₈ N ₂	<i>m</i> -Phenylenediamine.....	57.7	1.10696	1.62558	1.63390	1.65600	1.67617	(161)
C ₆ H ₈ N ₂	Phenylhydrazine.....	17.7	1.0983	1.60201	1.60926*	1.62761	1.64412	(29, † 106)
C ₆ H ₈ N ₂ O ₃	Methyl ethyloximinoeyanoacetate.....	20	1.1240	1.4538	1.4578	1.4677	1.4769	(152)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ^t	α	D	β	γ	Lit.
C ₆ H ₈ N ₂ O ₃	Ethyl methyloximinocynoacetate.....	20	1.1255	1.4527	1.4565	1.4664	1.4753	(152)
C ₆ H ₈ O	1, 4-Dimethylfuran.....	17.7	0.9026	1.43959	1.44270	1.45124	1.45832	(157)
C ₆ H ₈ O	α , α -Dimethylfurfuran.....	21.6	0.8871	1.43173	1.43508	1.44313	1.45008	(41)
C ₆ H ₈ O	Methyl- α -pyran.....	17.7	0.9187	1.45108	1.45421	1.46265	1.46977	(23)
C ₆ H ₈ O ₂	β -Methyl- Δ' -angelolactone.....	16.2	1.0602	1.46393	1.46740*	1.47566	1.48285	(28)
C ₆ H ₈ O ₄	Dimethyl maleate.....	20	1.1517	1.43863	1.44150	1.44901	1.45528	(45, † 144)
C ₆ H ₈ O ₄	Monoethyl fumarate.....	83	1.1149	1.43818	1.44088	1.45024		(49)
C ₆ H ₈ S	α , α' -Dimethylthiophene.....	13.4	0.9906	1.51233	1.51693*	1.52839	1.53842	(59, † 157)
C ₆ H ₈ S	β , β' -Dimethylthiophene.....	15	0.9932	1.51752	1.52217*	1.53339	1.54320	(59)
C ₆ H ₈ S	α -Ethylthiophene.....	21.2	0.9908	1.50834	1.51273	1.52359	1.53310	(59)
C ₆ H ₉ BrO ₃	Ethyl α -bromoacetoacetate.....	14.05	1.4294	1.46081	1.46337	1.47066	1.47665	(34)
C ₆ H ₉ BrO ₃	Ethyl γ -bromoacetoacetate.....	18.1	1.5276	1.48020	1.48311	1.49149	1.49834	(34)
C ₆ H ₉ CIN ₂	1, 3, 4-Trimethyl-5-chloropyrazole.....	20	1.1082	1.48368	1.48718*	1.49564	1.50299	(38)
C ₆ H ₉ ClO	α , β -Isohexenoyl chloride.....	14.2	1.0235	1.45994	1.46396*	1.47348	1.48185	(69)
C ₆ H ₉ ClO	β , γ -Hexenoyl chloride.....	19.6	1.0142	1.44405	1.44730*	1.45455	1.46038	(69)
C ₆ H ₉ ClO ₂	Ethyl α -chlorocrotonate.....	14.3	1.1073	1.45246	1.45580	1.46367	1.47063	(69)
C ₆ H ₉ ClO ₂	Ethyl β -chlorocrotonate.....	19.2	1.1018	1.45639	1.45985	1.46836	1.47538	(69)
C ₆ H ₉ ClO ₂	Ethyl α -chloroisocrotonate.....	18.0	1.1021	1.45068	1.45391*	1.46171	1.46868	(69, † 126)
C ₆ H ₉ ClO ₂	Ethyl β -chloroisocrotonate.....	14.4	1.0920	1.45317	1.45679	1.46561	1.47345	(69, † 126)
C ₆ H ₉ N	1, 4-Dimethylpyrrole.....	19.8	0.9353	1.50049	1.50357	1.51504	1.52469	(157)
C ₆ H ₉ N	2, 4-Dimethylpyrrole.....	13.7	0.9273	1.49536	1.49942*	1.50947	1.51828	(60)
C ₆ H ₉ N	2, 5-Dimethylpyrrole.....	16.8	0.9393	1.50354	1.50783*	1.51828	1.52750	(60)
C ₆ H ₉ N	β , γ -Hexenonitrile.....	18	0.8424	1.43023	1.43313	1.43980	1.44557	(69)
C ₆ H ₉ N	α , β -Isohexenonitrile.....	18.8	0.8556	1.43529	1.43796	1.44529	1.45129	(58, † 69)
C ₆ H ₉ NO	Trimethylisoxazole.....	14.5	0.9862	1.45118	1.45420	1.46150	1.46782	(31)
C ₆ H ₁₀	Cyclohexene.....	15.1	0.8147	1.44653	1.44921	1.45620	1.46194	(55, 104)
C ₆ H ₁₀	Diallyl.....	20	0.6880	1.39812	1.40102	1.40793	1.41385	(92)
C ₆ H ₁₀	Diisopropenyl.....	15	0.73074	1.4379	1.4421	1.4527	1.4622	(43)
C ₆ H ₁₀	2, 4-Hexadiene.....	12.5	0.72732	1.45133	1.45591	1.46800	1.47855	(43, 121)
C ₆ H ₁₀	Tetrahydrobenzene.....	22.1	0.8081	1.44235	1.44507	1.45184	1.45743	(104)
C ₆ H ₁₀ N ₂	1-Ethyl-3-methylpyrazole.....	14.9	0.9491	1.47113	1.47472*	1.48292	1.49008	(60)
C ₆ H ₁₀ N ₂	1, 3, 4-Trimethylpyrazole.....	22.5	0.9494	1.47145	1.47495*	1.48334	1.49061	(60)
C ₆ H ₁₀ N ₂	1, 3, 5-Trimethylpyrazole.....	37.5	0.9304	1.46526	1.46865*	1.47678	1.48409	(60)
C ₆ H ₁₀ O	Anhydro- δ -acetobutyl alcohol.....	16.2	0.9088	1.44535	1.44830*	1.45503	1.46091	(28)
C ₆ H ₁₀ O	Allylacetone.....	15.4	0.8470	1.41856	1.42126	1.42778	1.43327	(71, † 125)
C ₆ H ₁₀ O	Diethylketene.....	14.85	0.8338	1.41108	1.41355	1.41991		(18)
C ₆ H ₁₀ O	Cyclohexanone.....	16.8	0.9487	1.45004	1.45242	1.45834	1.46346	(55)
C ₆ H ₁₀ O	α -Methyl- β -ethylacrolein.....	14	0.8605	1.44427	1.44808	1.45761	1.46542	(43)
C ₆ H ₁₀ O	Mesityl oxide.....	20	0.8578	1.44028	1.44397	1.45352	1.46192	(43, † 95)
C ₆ H ₁₀ O ₂	Acetylacetone.....	17.0	0.9834	1.42167	1.42395		1.43431	(105)
C ₆ H ₁₀ O ₂	Propionylacetone.....	14.9	0.9639	1.44977	1.45391	1.46577	1.47686	(56)
C ₆ H ₁₀ O ₂	Hydroxymethylenediethylketone.....	48.9	0.9653	1.45375	1.45792	1.46955	1.47926	(17)
C ₆ H ₁₀ O ₂	Methylacetylacetone.....	13.5	0.9775	1.43537	1.43804	1.44596	1.45265	(17, † 56)
C ₆ H ₁₀ O ₂	Acetylacetone <i>O</i> -methyl ether.....	15.9	0.9744	1.46620	1.47068	1.48267	1.49367	(17)
C ₆ H ₁₀ O ₂	Cyclopentylcarboxylic acid.....	15.5	1.0555	1.45329		1.46142	1.46609	(130)
C ₆ H ₁₀ O ₂	α -Ethylcrotonic acid.....	56.1	0.9484	1.44022	1.44260*	1.45102	1.45842	(69)
C ₆ H ₁₀ O ₂	α , β -Hexenic acid.....	40	0.9490	1.44360	1.44666*	1.45538	1.46287	(69)
C ₆ H ₁₀ O ₂	α , β -Isohexenic acid.....	16.0	0.9589	1.44706	1.45060*	1.45931	1.46689	(69)
C ₆ H ₁₀ O ₂	Ethyl crotonate.....	20	0.9237	1.42189	1.42495	1.43240	1.43872	(43, † 94, 95)
C ₆ H ₁₀ O ₂	Ethyl isocrotonate.....	19.6	0.9246	1.42256	1.42590*	1.43285	1.43974	(69)
C ₆ H ₁₀ O ₂	Methyl β , β -dimethylacrylate.....	19.8	0.9337	1.42901	1.43207	1.43985	1.44663	(43)
C ₆ H ₁₀ O ₃	δ -Methoxy- γ -valerolactone.....	23.2	1.1200	1.44313	1.44533	1.45076	1.45540	(80)
C ₆ H ₁₀ O ₃	Ethyl acetoacetate.....	16.6	1.0320	1.41851	1.42092	1.42660	1.43155	(93, 123 †)
C ₆ H ₁₀ O ₃	Ethyl α -hydroxymethylenepropionate..	16.1	1.0268	1.42559	1.42876	1.43602	1.44269	(17)
C ₆ H ₁₀ O ₃	Methyl α , β -butyleneoxide- δ -carboxylate	24.7	1.0726	1.42380	1.42589	1.43107	1.43545	(80)
C ₆ H ₁₀ O ₃	Methyl methylacetoacetate.....	23.8	1.0304	1.41416	1.41629	1.42184	1.42648	(9)
C ₆ H ₁₀ O ₄	Diethyl oxalate.....	20	1.0793	1.40824	1.41043	1.41564	1.41987	(18, 93 †)
C ₆ H ₁₀ O ₄	Dimethyl succinate.....	18.3	1.1202	1.41774	1.41976		1.42868	(105)
C ₆ H ₁₀ O ₄	Methyl hydrogen pyrotartrate.....	20.7	1.1436	1.43006	1.43230	1.43764	1.44195	(102)
C ₆ H ₁₀ S	Allyl sulfide.....	26.8	0.8876	1.48384	1.48770	1.49787	1.50637	(160)
C ₆ H ₁₁ ClO ₂	Ethyl chlorobutyrate.....	20	1.0517	1.42231	1.42458	1.42990	1.43434	(93)
C ₆ H ₁₁ N	Capronitrile.....	14.3	0.8069	1.40647	1.40851		1.41739	(106)
C ₆ H ₁₁ NO	Mesityloxime.....	21.0	0.9417	1.48655	1.49083	1.50219	1.51209	(106)
C ₆ H ₁₁ NO	α -Mesityl oxide oxime.....	14.5	0.9494	1.48521	1.48961*	1.50021	1.50962	(74)

Formula	Name	t_f , °C	$d_4^{t_f}$	α	D	β	γ	Lit.
C ₆ H ₁₁ NO ₂	Ethyl β -aminocrotonate.....	18.8	1.0219	1.49479	1.50067	1.51647	1.53160	(105, 106, 126)
C ₆ H ₁₁ NO ₃	Ethyl dimethyloxamate.....	22.5	1.0735	1.43880	1.44144	1.44830	1.45389	(109)
C ₆ H ₁₂	Cyclohexane.....	10.85	0.7872	1.42910	1.43119	1.43668	1.44116	(55)
C ₆ H ₁₂	Hexylene.....	23.3	0.6792	1.39196	1.39446	1.40071	1.40590	(104, † 148)
C ₆ H ₁₂ N ₂	Dimethylketazine.....	24.5	0.8381	1.44746	1.45102	1.46008	1.46805	(109)
C ₆ H ₁₂ N ₂	Propylglyoxalidine.....	17.0	0.9641	1.48383	1.48708	1.49518	1.50206	(109)
C ₆ H ₁₂ N ₂ O ₄	Methyl <i>n</i> -butylnitrocarbamate.....	22.0	1.1396	1.44561	1.44859	1.45609	1.46249	(109)
C ₆ H ₁₂ N ₂ O ₄	Methyl isobutylnitrocarbamate.....	21.9	1.1346	1.44315	1.44614	1.45354	1.45996	(109)
C ₆ H ₁₂ N ₂ O ₄	Methyl <i>sec</i> -butylnitrocarbamate.....	23.3	1.1248	1.43879	1.44167	1.44895	1.45532	(109)
C ₆ H ₁₂ O	2-Hexen-4-ol.....	16.7	0.84697	1.43417	1.43688	1.44370	1.44948	(121)
C ₆ H ₁₂ O	Cyclohexanol.....	22.6	0.9463	1.46330	1.46560	1.47141	1.47623	(55)
C ₆ H ₁₂ O	Ethyl propyl ketone.....	22	0.81491	1.39683	1.39899	1.40402	1.40813	(125)
C ₆ H ₁₂ O	Methyl isobutyl ketone.....	17.4	0.80316	1.39500	1.39694	1.40235	1.40638	(125)
C ₆ H ₁₂ O ₂	δ -Acetobutyl alcohol.....	15.4	0.9943	1.44937	1.45180*	1.45752	1.46234	(28)
C ₆ H ₁₂ O ₂	Caproic acid.....	19.6	0.9220	1.41235	1.41449	1.41964	1.42397	(125, † 147)
C ₆ H ₁₂ O ₂	Amyl formate.....	11.5	0.8832	1.3910	1.3951	1.4000	1.4084	(132)
C ₆ H ₁₂ O ₂	Ethyl butyrate.....	18	0.8797	1.39099	1.39302	1.39778	1.40166	(94, 134)
C ₆ H ₁₂ O ₂	Isobutyl acetate.....	17.8	0.87306	1.38905	1.39114	1.39597	1.39994	(125)
C ₆ H ₁₂ O ₃	Paraldehyde.....	20	0.9943	1.40304	1.40486	1.40948	1.41302	(93)
C ₆ H ₁₂ O ₄	Methyl α , α -dimethoxypropionate.....	17.6	1.0678	1.41035	1.41221	1.41721	1.42130	(5)
C ₆ H ₁₃ N	α -Methylpiperidine.....	23.6	0.8436	1.44384	1.44639		1.45769	(106)
C ₆ H ₁₃ N	β -Methylpiperidine.....	24.3	0.8446	1.44380	1.44627		1.45760	(106)
C ₆ H ₁₃ N	γ -Methylpiperidine.....	21.6	0.8184	1.43516	1.43779		1.44951	(106)
C ₆ H ₁₃ N	Propylpropylidencamine.....	17.5	0.7604	1.41032	1.41269	1.41878	1.42380	(109)
C ₆ H ₁₃ NO ₂	Methyl <i>n</i> -butylcarbamate.....	23.3	0.9689	1.42647	1.42888	1.43448	1.43906	(109)
C ₆ H ₁₃ NO ₂	Methyl isobutylcarbamate.....	21.6	0.9651	1.42509	1.42750	1.43300	1.43765	(109)
C ₆ H ₁₃ NO ₂	Methyl <i>sec</i> -butylcarbamate.....	24.9	0.9651	1.42380	1.42625	1.43168	1.43616	(109)
C ₆ H ₁₄	Hexane.....	20	0.6603	1.37337	1.37536	1.37988	1.38365	(92, 148)
C ₆ H ₁₄ N ₂ O ₂	<i>N</i> -Hexylnitroamine.....	25.2	1.0037	1.45610	1.45931	1.46733	1.47410	(109)
C ₆ H ₁₄ O ₂	Acetal.....	20	0.8314	1.38000	1.38193	1.38636	1.39007	(93)
C ₆ H ₁₆ N	Dipropylamine.....	19.5	0.7384	1.40242	1.40455		1.41453	(106)
C ₆ H ₁₆ N	Triethylamine.....	20	0.7277	1.39804	1.40032	1.40613	1.41092	(92, 106)
C ₆ H ₁₆ N ₃	Triformalmethylamine.....	19.0	0.9178	1.46039	1.46320	1.47047	1.47653	(109)
C ₆ H ₁₆ O ₂ P	Diethyl ethylphosphinate.....	10	1.0259	1.41434	1.41627	1.42107	1.42524	(2)
C ₆ H ₁₆ O ₃ P	Diethyl phosphite.....	10	0.9687	1.41073	1.41309	1.41917	1.42423	(2)
C ₆ H ₁₆ O ₄ P	Triethyl phosphate.....	10	1.0682	1.40436	1.40616	1.41073	1.41449	(2)
C ₇ H ₆ ClO	<i>o</i> -Chlorobenzaldehyde.....	21.7	1.2474	1.55972	1.56564	1.58274	1.59807	(47)
C ₇ H ₆ ClO	<i>m</i> -Chlorobenzaldehyde.....	20.2	1.2410	1.55908	1.56500	1.58184	1.59702	(47)
C ₇ H ₆ ClO	<i>p</i> -Chlorobenzaldehyde.....	61.0	1.1958	1.54878	1.55525	1.57341		(47)
C ₇ H ₆ ClO	Benzoyl chloride.....	20	1.2122	1.54751	1.55369	1.56964	1.58411	(80, 95†)
C ₇ H ₆ N	Benzonitrile.....	25.5	1.0003	1.52035	1.52570	1.53942	1.55144	(106)
C ₇ H ₆ NO	Anthranil.....	14.9	1.1866	1.57891	1.58676*	1.60778	1.62923	(29, † 117, 118)
C ₇ H ₆ NO	Indoxazene.....	15.9	1.1744	1.55824	1.56446*	1.58012	1.59448	(31)
C ₇ H ₆ NO	Phenyl isocyanate.....	19.6	1.0956	1.53139	1.53684	1.55082	1.56303	(106)
C ₇ H ₆ NS	Phenyl isothiocyanate.....	23.4	1.1289	1.63959	1.64918	1.67513	1.69938	(158, 159)
C ₇ H ₆ O	Benzaldehyde.....	17.6	1.0492	1.53948	1.54629	1.56283	1.57731	(43)
C ₇ H ₆ O ₂	Salicylaldehyde.....	19.7	1.1671	1.56526	1.57358	1.59674	1.62097	(41)
C ₇ H ₇ BrO	<i>o</i> -Bromoanisole.....	20	1.5018	1.56690	1.57245	1.58695		(91)
C ₇ H ₇ BrO	<i>p</i> -Bromoanisole.....	20	1.4569	1.55507	1.56051	1.57462		(91)
C ₇ H ₇ BrS	<i>o</i> -Bromophenyl methyl sulfide.....	20	1.5216	1.62495	1.63190	1.65020		(91)
C ₇ H ₇ Cl	<i>o</i> -Chlorotoluene.....	20.2	1.0795	1.52040	1.52466	1.53700	1.54739	(47)
C ₇ H ₇ Cl	<i>m</i> -Chlorotoluene.....	18.7	1.0760	1.51822	1.52252	1.53473	1.54505	(47)
C ₇ H ₇ Cl	<i>p</i> -Chlorotoluene.....	24.35	1.0651	1.51504	1.51925	1.53146	1.54158	(47)
C ₇ H ₇ Cl	Benzyl chloride.....	15.4	1.1138	1.5367	1.5415	1.5542	1.5652	(140)
C ₇ H ₇ I	<i>o</i> -Iodotoluene.....	15.9	1.7192	1.60400	1.61066	1.62742		(47)
C ₇ H ₇ NO	α -Benzaldoxime.....	13.8	1.1160	1.58767	1.59558*	1.61544	1.63345	(74, 106)
C ₇ H ₇ NO ₂	<i>o</i> -Nitrotoluene.....	20.4	1.1625	1.54104	1.54739		1.57933	(106)
C ₇ H ₇ NO ₃	<i>o</i> -Nitroanisole.....	20	1.2527	1.55468	1.56188	1.58289		(91)
C ₇ H ₇ NO ₃	<i>p</i> -Nitroanisole.....	60	1.2192	1.56385	1.57072	1.59262		(91)
C ₇ H ₈	Toluene.....	16.35	0.8684	1.49365	1.49782	1.50967	1.51970	(20, † 92, 132, 134, 148)
C ₇ H ₈ N ₂ O	Nitrosomethylaniline.....	22.7	1.1213	1.56832	1.57602		1.61585	(106)
C ₇ H ₈ O	Benzyl alcohol.....	20	1.0429	1.53474	1.53955	1.55178	1.56232	(92, † 131)
C ₇ H ₈ O	<i>m</i> -Cresol.....	18	1.0363	1.53756	1.54246	1.55590	1.56727	(145)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ²⁵	α	D	β	γ	Lit.
C ₇ H ₈ O	Anisole.....	16.5	0.9989	1.51482	1.51950	1.53235	1.54338	(47, 91, 145, † 155, 156)
C ₇ H ₈ OS	α -Methyl- α' -acetothienone.....	24.7	1.1185	1.55329	1.56038*	1.57900	1.59760	(59)
C ₇ H ₈ OS	α -Propiothienone.....	15.0	1.1361	1.55148	1.55776*	1.57400	1.58949	(59)
C ₇ H ₈ O ₂ S	Ethyl α -thiophenecarboxylate.....	16.3	1.1623	1.52181	1.52719*	1.54046	1.55273	(59)
C ₇ H ₈ O ₃	Methyl salicylate.....	18.1	1.1855	1.53149	1.53773	1.55371	1.56921	(41)
C ₇ H ₉ Cl ₃ O ₂	Methyl γ , γ , γ -trichloro- β -acetylbuty- rate.....	14.5	1.3935	1.46560	1.46815	1.47423	1.47947	(81)
C ₇ H ₉ N	Benzylamine.....	19.5	0.9827	1.53918	1.54406	1.55670	1.56753	(106)
C ₇ H ₉ N	β -Ethylpyridine.....	22.5	0.9401	1.49783	1.50214		1.52217	(106)
C ₇ H ₉ N	Methylaniline.....	21.2	0.9851	1.56348	1.57021	1.58823	1.60322	(106)
C ₇ H ₉ N	<i>o</i> -Toluidine.....	20	0.9986	1.56650	1.57276	1.58945	1.60425	(92, 106, † 145)
C ₇ H ₉ N	<i>m</i> -Toluidine.....	22.4	0.9962	1.56473	1.57106		1.60267	(106)
C ₇ H ₉ N	<i>p</i> -Toluidine.....	59.1	0.9538	1.54710	1.55324		1.58351	(106)
C ₇ H ₉ NO	<i>o</i> -Anisidine.....	20	1.0923	1.56884	1.57536	1.59235		(91)
C ₇ H ₉ NO	<i>p</i> -Anisidine.....	67	1.0605	1.54938	1.55592	1.57244		(91)
C ₇ H ₉ NO	1-Cyanocyclohexan-2-one.....	15.9	1.0741	1.47689	1.47932*	1.48623	1.49156	(39)
C ₇ H ₉ NO	β , γ -Tetrahydrobenzoxazole.....	17.2	1.0996	1.49631	1.49953*	1.50714	1.51381	(31)
C ₇ H ₉ NO ₂	Furylimido ethyl ether.....	17.8	1.0782	1.48842	1.49297	1.50451	1.51508	(109)
C ₇ H ₉ NO ₂	Ethyl α -cyanoacetoacetate.....	18.8	1.0255	1.44988	1.45302	1.46172	1.46888	(58)
C ₇ H ₉ NO ₃	Ethyl α -cyanoacetoacetate.....	20	1.1107	1.4669	1.4710	1.4816	1.4905	(138)
C ₇ H ₉ NS	<i>o</i> -Aminophenylmethyl sulfide.....	17	1.1333	1.61879	1.62632	1.64659		(91)
C ₇ H ₁₀	1, 3, 5-Heptatriene.....	19.8	0.7636	1.50786	1.51604	1.53754	1.55742	(27)
C ₇ H ₁₀ N ₂	<i>asym.</i> -Methylphenylhydrazine.....	19.7	1.0404	1.57630	1.58316*	1.62761	1.64412	(29, † 106)
C ₇ H ₁₀ N ₂	<i>sym.</i> -Methylphenylhydrazine.....	23.1	1.0296	1.56501	1.57146*	1.60111	1.61757	(29)
C ₇ H ₁₀ N ₂ O ₃	Ethyl ethyloximinocycanoacetate.....	20	1.0818	1.4494	1.4530	1.4624	1.4710	(152)
C ₇ H ₁₀ O	1-Methyl-1-cyclohexen-3-one.....	18.7	0.9707	1.49137	1.49547	1.50624	1.51573	(44)
C ₇ H ₁₀ O ₂	Δ^1 -Tetrahydrobenzoic acid.....	47.0	1.0719	1.48576	1.49023*	1.49882	1.50705	(26)
C ₇ H ₁₀ O ₂	γ -Acetoxyvalerolactone.....	78.6	1.1231	1.42111	1.42355	1.42862	1.43292	(49)
C ₇ H ₁₀ O ₂	α , α -Dimethylangelolactone.....	13.7	0.9818	1.43314	1.43593	1.44247	1.44820	(28)
C ₇ H ₁₀ O ₂	Hydroxymethylene-1-cyclohexan-2-one..	20.5	1.0848	1.50697	1.51218	1.52774		(17, 56)
C ₇ H ₁₀ O ₂	Ethyl β -vinylacrylate.....	22.9	0.9351	1.46948	1.47504*	1.48928	1.50252	(27)
C ₇ H ₁₀ O ₃	Ethyl β -acetylacrylate.....	18.1	1.0387	1.44987	1.45346*	1.46250	1.47081	(27)
C ₇ H ₁₀ O ₄	Ethyl acetoxalate.....	17.6	1.1275	1.46976	1.47498		1.50054	(105)
C ₇ H ₁₀ O ₄	Ethyl acetoxymethyleneacetate.....	18.1	1.0905	1.44382	1.44742	1.45601	1.46382	(17)
C ₇ H ₁₀ O ₄	Ethyl hydroxymethyleneacetoacetate...	16.9	1.1338	1.46925	1.47376	1.48565	1.49673	(17)
C ₇ H ₁₀ O ₄	Dimethyl citraconate.....	20	1.1104	1.44455	1.44759	1.45551	1.46218	(45, † 144)
C ₇ H ₁₀ O ₄	Dimethyl itaconate.....	20	1.1218	1.44126	1.44412	1.45099	1.45685	(144)
C ₇ H ₁₀ O ₄	Dimethyl mesaconate.....	20	1.12097	1.45217	1.45568	1.46453	1.47225	(45, † 144)
C ₇ H ₁₀ O ₅	Diethyl oxomalonate.....	15.6	1.1419	1.41626	1.41865	1.42439		(18)
C ₇ H ₁₁ ClO	α , β -Isoheptenyl chloride.....	17.1	0.9940	1.45887	1.46259*	1.47202	1.48011	(69)
C ₇ H ₁₁ ClO ₄	Diethyl chloromalonate.....	19.3	1.2047	1.43299	1.43527		1.44568	(105)
C ₇ H ₁₁ N	α , β -Isoheptenonitrile.....	12	0.8286	1.44020	1.44346*	1.45132	1.45807	(58, 69†)
C ₇ H ₁₁ N	Δ^2 -Isoheptenonitrile.....	22.3	0.8241	1.42691	1.42932	1.43614	1.44166	(58)
C ₇ H ₁₁ N	2, 3, 5-Trimethylpyrrole.....	15.8	0.9351	1.50474	1.50888*	1.51892	1.52745	(60)
C ₇ H ₁₂	2, 4-Dimethyl-2, 4-pentadiene.....	17.3	0.7412	1.43663	1.44055	1.45006	1.45842	(43)
C ₇ H ₁₂	1-Heptene.....	20	0.7458	1.41822	1.42073	1.42690	1.43212	(95, † 150)
C ₇ H ₁₂	Methenecyclohexane.....	16.4	0.8021	1.44863	1.45182	1.45879	1.46488	(46, † 55)
C ₇ H ₁₂	1-Methyl-1-cyclohexene.....	18.5	0.8115	1.44744	1.45033	1.45711	1.46293	(46)
C ₇ H ₁₂ Br ₂ O ₂	Ethyl α , β -dibromovalerate.....	15.4	1.6199	1.49527	1.49863*	1.50656	1.51332	(69)
C ₇ H ₁₂ N ₂	1, 3, 4, 5-Tetramethylpyrazole.....	23.4	0.9442	1.47634	1.47974*	1.48811	1.49528	(60)
C ₇ H ₁₂ O	Allylpropenyl carbinol.....	20	0.8612	1.45089	1.45414*	1.46191	1.46840	(27)
C ₇ H ₁₂ O	Cycloheptanone.....	21.9	0.9495	1.45801	1.46027	1.46646	1.47149	(55)
C ₇ H ₁₂ O	1-Methylcyclohexan-2-one.....	14.6	0.9300	1.44827	1.45049	1.45653	1.46135	(55)
C ₇ H ₁₂ O	1-Methylcyclohexan-3-one.....	25.15	0.9139	1.44092	1.44313	1.44914	1.45394	(55)
C ₇ H ₁₂ O	1-Methylcyclohexan-4-one.....	24.4	0.9119	1.44092	1.44322	1.44918	1.45413	(55, † 61)
C ₇ H ₁₂ O ₂	Dimethylacetylacetone.....	27.8	0.9496	1.42386	1.42615	1.43183	1.43663	(17)
C ₇ H ₁₂ O ₂	Ethylacetylacetone.....	16.9	0.9560	1.43667	1.43968	1.44736	1.45447	(17, † 56)
C ₇ H ₁₂ O ₂	Hydroxymethylenemethyl- <i>tert</i> -b u t y l ketone.....	20.15	0.9347	1.44834	1.45263	1.46377	1.47449	(17)
C ₇ H ₁₂ O ₂	Acetylacetone <i>O</i> -ethyl ether.....	16.3	0.9477	1.46204	1.46648	1.47759	1.48790	(17)
C ₇ H ₁₂ O ₂	Cyclopentylacetic acid.....	34.0	1.0083	1.44579		1.45378	1.45838	(130)
C ₇ H ₁₂ O ₂	Cyclohexylcarboxylic acid.....	33.8	1.0253	1.45382		1.46197	1.46666	(130)
C ₇ H ₁₂ O ₂	α , β -Isoheptenic acid.....	15.3	0.9458	1.45118	1.45460*	1.46328	1.47034	(69)

Formula	Name	t , °C	d_4^t	α	D	β	γ	Lit.
C ₇ H ₁₂ O ₂	Δ^2 -Isoheptenic acid.....	17.2	0.9430	1.44274	1.44569	1.45354	1.46017	(58)
C ₇ H ₁₂ O ₂	α -Methyl- Δ^2 -hexenic acid.....	13.45	0.9477	1.43980	1.44246	1.44945	1.45512	(53)
C ₇ H ₁₂ O ₂	γ -Methyl- Δ^2 -hexenic acid.....	14.2	0.9706	1.45027	1.45290	1.46001	1.46601	(53)
C ₇ H ₁₂ O ₂	Ethyl angelate.....	19.5	0.9178	1.42781	1.43102*	1.43802	1.44435	(69)
C ₇ H ₁₂ O ₂	Ethyl β , β -dimethylacrylate.....	15.0	0.9171	1.43335	1.43679*	1.44462	1.45177	(69)
C ₇ H ₁₂ O ₂	Ethyl α , β -pentenate.....	21.9	0.9072	1.42737	1.43047*	1.43788	1.44422	(69)
C ₇ H ₁₂ O ₂	Ethyl tiglate.....	19.5	0.9247	1.43236	1.43554*	1.44290	1.44927	(69)
C ₇ H ₁₂ O ₃	δ -Ethoxy- γ -valerolactone.....	24.9	1.0715	1.43860	1.44082	1.44621	1.45089	(80)
C ₇ H ₁₂ O ₃	Ethyl α -ethoxyacrylate.....	17.2	0.9956	1.42941	1.43241	1.43925	1.44536	(5)
C ₇ H ₁₂ O ₃	Ethyl β -ethoxyacrylate.....	16.7	0.9965	1.44497	1.44852	1.45765	1.46574	(5)
C ₇ H ₁₂ O ₃	Ethyl methylacetoacetate.....	17.8	1.0010	1.41876	1.42066	1.42671	1.43154	(9,† 105)
C ₇ H ₁₂ O ₃	Methyl dimethylacetoacetate.....	16.8	1.0122	1.41946	1.42166	1.42701	1.43145	(9,† 105)
C ₇ H ₁₂ O ₃	Ethyl levulinate.....	16.2	1.0168	1.42192	1.42416	1.42955	1.43415	(6)
C ₇ H ₁₂ O ₃	Methyl cyclopentan-1-ol-1-carboxylate..	17.0	1.1047	1.45445	1.45672	1.46237	1.46707	(63)
C ₇ H ₁₂ O ₄	Diethyl malonate.....	17.2	1.0570	1.41255	1.41508	1.41977	1.42395	(9,† 105)
C ₇ H ₁₂ O ₄	Dimethyl dimethylmalonate.....	24.2	1.0589	1.41106	1.41312	1.41816	1.42219	(9)
C ₇ H ₁₂ O ₄	Dimethyl pyrotartrate.....	19.6	1.0692	1.41841	1.42042		1.42939	(102)
C ₇ H ₁₂ O ₄	Ethyl hydrogen pyrotartrate.....	20.2	1.0982	1.42899	1.43121		1.44066	(102)
C ₇ H ₁₄ N ₂	Dipropylcarbimide.....	23.0	0.8381	1.44253	1.44541	1.45244	1.45830	(106)
C ₇ H ₁₄ N ₂	Dipropylcyanamide.....	24.4	0.8572	1.42744	1.42979	1.43537	1.44006	(106)
C ₇ H ₁₄ N ₂ O ₄	Ethyl <i>n</i> -butylnitrocarbamate.....	20.7	1.0985	1.44256	1.44546	1.45270	1.45887	(109)
C ₇ H ₁₄ N ₂ O ₄	Ethyl isobutylnitrocarbamate.....	20.5	1.0941	1.44043	1.44331	1.45052	1.45683	(109)
C ₇ H ₁₄ N ₂ O ₄	Ethyl <i>sec</i> -butylnitrocarbamate.....	21.4	1.0861	1.43685	1.43972	1.44681	1.45287	(109)
C ₇ H ₁₄ O	Butenyldimethyl carbinol.....	16.2	0.83822	1.43192	1.43446	1.44082	1.44622	(125)
C ₇ H ₁₄ O	1-Methyleyclohexan-1-ol.....	24.65	0.9251	1.45631	1.45874	1.46428	1.46908	(55)
C ₇ H ₁₄ O	1-Methyleyclohexan-2-ol.....	13.4	0.9333	1.46352	1.46585	1.47180	1.47665	(55)
C ₇ H ₁₄ O	1-Methyleyclohexan-3-ol.....	24.4	0.9152	1.45497	1.45734	1.46319	1.46819	(55)
C ₇ H ₁₄ O	1-Methyleyclohexan-4-ol.....	20.7	0.9175	1.45595	1.45833	1.46406	1.46897	(55,† 61)
C ₇ H ₁₄ O	5-Methyl-1-hexen-5-ol.....	16.2	0.8382	1.43194	1.43446	1.44082	1.44622	(71)
C ₇ H ₁₄ O	Oenanthaldehyde.....	20	0.8495	1.42339	1.42571	1.43094	1.43514	(93)
C ₇ H ₁₄ O	Dipropyl ketone.....	21.7	0.8160	1.40521	1.40732		1.41650	(105)
C ₇ H ₁₄ O ₂	Cycloacetobutyl methyl ether.....	16.7	0.9485	1.42629	1.42830*	1.43324	1.43742	(28)
C ₇ H ₁₄ O ₂	Heptylic acid.....	19.8	0.91846	1.41932	1.42162	1.42682	1.43132	(125,† 130, 147)
C ₇ H ₁₄ O ₂	Ethyl isovalerate.....	18.8	0.86840	1.39520	1.39671	1.40203	1.40605	(125)
C ₇ H ₁₄ O ₂	Isoamyl acetate.....	17.9	0.87450	1.39958	1.40170	1.40658	1.41072	(125,† 134)
C ₇ H ₁₅ N	β -Ethylpiperidine.....	23.2	0.8565	1.45058	1.45310		1.46449	(106)
C ₇ H ₁₅ N	γ -Ethylpiperidine.....	18.9	0.8260	1.44192	1.44450	1.45103	1.45647	(106)
C ₇ H ₁₅ N	γ -Dimethylpiperidylamine.....	19.2	0.7585	1.41940	1.42203	1.42890	1.43466	(106)
C ₇ H ₁₅ NO	Dipropylketoxime.....	24.1	0.8877	1.44456	1.44724		1.45914	(106)
C ₇ H ₁₅ NO ₂	Ethyl <i>n</i> -butylcarbamate.....	25.6	0.9434	1.42552	1.42734	1.43339	1.43784	(109)
C ₇ H ₁₅ NO ₂	Ethyl isobutylcarbamate.....	26.7	0.9386	1.42302	1.42530	1.43087	1.43534	(109)
C ₇ H ₁₅ NO ₂	Ethyl <i>sec</i> -butylcarbamate.....	26.0	0.9404	1.42430	1.42666	1.43214	1.43652	(109)
C ₇ H ₁₆	Heptane.....	23	0.6809	1.3826	1.3867	1.3917	1.3991	(132)
C ₇ H ₁₆ O	<i>n</i> -Heptyl alcohol.....	22.4		1.42116	1.42326	1.42843	1.43281	(131)
C ₇ H ₁₆ O ₃	Triethyl orthoformate.....	18.8	0.8971	1.39034	1.39218	1.39676	1.40044	(108)
C ₈ H ₄ Cl ₂ O ₂	Phthalyl chloride.....	15.5	1.4077	1.56505	1.57099	1.45676	1.60116	(80,† 95)
C ₈ H ₄ Cl ₂ O ₂	Isophthalyl chloride.....	46.9	1.3872	1.56336	1.56999	1.58672	1.60236	(80)
C ₈ H ₆	Phenylacetylene.....	12.5	0.9371	1.54604	1.5524	1.57986	1.59856	(150)
C ₈ H ₆ N ₂	Quinoxaline.....	48.0	1.1334	1.61428	1.62311	1.64858	1.67341	(109)
C ₈ H ₆ O	Coumarone.....	22.7	1.0913	1.55787	1.56450	1.58101	1.59609	(41)
C ₈ H ₆ O ₂	<i>o</i> -Hydroxyphenylacetic acid lactone....	15.4	1.2220	1.54781	1.55337	1.56552	1.57667	(19)
C ₈ H ₆ O ₂	Phthalide.....	99.1	1.1636	1.53021	1.53560	1.54896		(49)
C ₈ H ₆ S	Thionaphthene.....	36.2	1.1484	1.62509	1.63324	1.65439	1.67386	(41)
C ₈ H ₇ N	Benzyl cyanide.....	20.2	1.0176	1.51977	1.52422		1.54552	(106)
C ₈ H ₇ N	<i>o</i> -Tolunitrile.....	23.1	0.9896	1.52200	1.52720		1.55228	(106)
C ₈ H ₇ NO	Methylantranil.....	19.95	1.1334	1.57019	1.57795	1.60005	1.62206	(117, 118†)
C ₈ H ₈	Cinnamene.....	21	0.9111	1.5318	1.5446	1.5615	1.5936	(132)
C ₈ H ₈	Styrene.....	17	0.90595	1.53699	1.54344	1.56036	1.57588	(14, 43,† 155, 156)
C ₈ H ₈ Cl ₂ O	<i>o</i> -Methyldichloromethylketodihydro- benzene.....	44	1.2573	1.52275	1.52908	1.54159	1.55792	(52)
C ₈ H ₈ Cl ₂ O	<i>p</i> -Methyldichloromethylketodihydro- benzene.....	51		1.53141	1.53644	1.54779	1.55832	(52)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ²⁰	α	D	β	γ	Lit.
C ₈ H ₈ Cl ₂ O	1-Methyl-1-dichloromethyl-3, 5-cyclohexadien-2-one.....	33.5	1.2700	1.52766	1.53284	1.54660		(45)
C ₈ H ₈ Cl ₂ O	1-Methyl-1-dichloromethyl-4-keto-2, 5-cyclohexadiene.....	51		1.53141	1.53644	1.54779	1.55832	(45)
C ₈ H ₈ N ₂	Methylmethenyl- <i>o</i> -phenylenediamine...	17.1	1.1283	1.59454	1.60133	1.61906	1.63498	(109)
C ₈ H ₈ O	Coumarane.....	13.3	1.0800	1.54485	1.54997	1.56374	1.57572	(16)
C ₈ H ₈ O	<i>o</i> -Hydroxystyrene.....	35.7	1.0466	1.56997	1.57724	1.59661	1.61474	(14)
C ₈ H ₈ O	Phenylacetaldehyde.....	19.6	1.0272	1.52056	1.52546	1.53738	1.54783	(43)
C ₈ H ₈ O	<i>o</i> -Toluic aldehyde.....	19.0	1.0386	1.54233	1.54852	1.56502	1.57978	(41)
C ₈ H ₈ O	<i>m</i> -Toluic aldehyde.....	21.4	1.0189	1.53444	1.54068	1.55676	1.57168	(41)
C ₈ H ₈ O	<i>p</i> -Toluic aldehyde.....	16.6	1.0195	1.54015	1.54693	1.56413	1.58000	(8, 41)
C ₈ H ₈ O	Acetophenone.....	19.1	1.0293	1.52832	1.53427	1.55003	1.56103	(43, † 44, 105, 145)
C ₈ H ₈ O ₂	Anisaldehyde.....	12.7	1.1302	1.56784	1.57641	1.59764		(41)
C ₈ H ₈ O ₂	<i>p</i> -Homosalicylaldehyde.....	59.2	1.0913	1.53921	1.54655	1.56840		(41)
C ₈ H ₈ O ₂	<i>m</i> -Methoxybenzaldehyde.....	13.9	1.1245	1.55006	1.55656	1.57486	1.59228	(41)
C ₈ H ₈ O ₂	<i>o</i> -Hydroxyacetophenone.....	21.3	1.1303	1.55061	1.55797	1.57821	1.59931	(41)
C ₈ H ₈ O ₂	Salicylaldehyde methyl ether.....	20.2	1.1326	1.55245	1.55966	1.57947	1.59912	(41)
C ₈ H ₈ O ₂	Methyl benzoate.....	16.0	1.0905	1.51309	1.51810	1.53060	1.54157	(43, 44 †)
C ₈ H ₈ O ₃	Methyl salicylate.....	21		1.5206	1.5319	1.5241	1.5810	(134)
C ₈ H ₈ O ₄	Ethyl coumalate.....	39.2	1.2094	1.50176	1.50655	1.52081	1.53396	(23)
C ₈ H ₉ Br	<i>asym.</i> -Bromo- <i>o</i> -xylene.....	18.4	1.3708	1.55240	1.55712	1.57058	1.58194	(47)
C ₈ H ₉ Br	Bromo- <i>p</i> -xylene.....	18.5	1.3582	1.54676	1.55138	1.56467	1.57589	(47)
C ₈ H ₉ I	<i>asym.</i> -Iodo- <i>o</i> -xylene.....	18.35	1.6334	1.59884	1.60490	1.62163		(47)
C ₈ H ₉ I	<i>vic.</i> -Iodo- <i>o</i> -xylene.....	19.75	1.6395	1.60131	1.60736	1.62372		(47)
C ₈ H ₉ I	<i>asym.</i> -Iodo- <i>m</i> -xylene.....	16.3	1.6282	1.59436	1.60080	1.61687		(47)
C ₈ H ₉ I	<i>sym.</i> -Iodo- <i>m</i> -xylene.....	18.5	1.6085	1.59082	1.59672	1.61312		(47)
C ₈ H ₉ I	Iodo- <i>p</i> -xylene.....	17.4	1.6168	1.59273	1.59917	1.61508		(47)
C ₈ H ₉ NO	α -Benzaldoxime <i>O</i> -methyl ether.....	17.0	1.0227	1.54311	1.55001*	1.56798	1.58494	(74)
C ₈ H ₉ NO ₂	<i>aci</i> -Phenylnitromethane methyl ether...	15.0	1.1241	1.57895	1.58708*	1.60751	1.62445	(74)
C ₈ H ₁₀	Ethylbenzene.....	14.5	0.8708	1.49423	1.49828	1.50953	1.51904	(20, † 95, 148)
C ₈ H ₁₀	<i>o</i> -Xylene.....	15.5	0.8837	1.50368	1.50777	1.51960	1.52958	(20, † 105, 148)
C ₈ H ₁₀	<i>m</i> -Xylene.....	14.85	0.8686	1.49548	1.49962	1.51128	1.52112	(20, † 148)
C ₈ H ₁₀	<i>p</i> -Xylene.....	16.2	0.8624	1.49335	1.49734	1.50912	1.51902	(20, † 105, 148)
C ₈ H ₁₀ N ₂ O ₂	Benzylmethylnitroamine.....	25.7	1.1706	1.54621	1.55150	1.56531	1.57750	(109)
C ₈ H ₁₀ O	<i>o</i> -Methoxytoluene.....	15.3	0.9854	1.51447	1.51888	1.53150	1.54238	(16, † 47)
C ₈ H ₁₀ O	<i>m</i> -Methoxytoluene.....	12.85	0.9784	1.51184	1.51638	1.52892	1.53981	(47)
C ₈ H ₁₀ O	<i>p</i> -Methoxytoluene.....	19.3	0.9709	1.50797	1.51237	1.52488	1.53557	(47)
C ₈ H ₁₀ O	Phenetole.....	13.7	0.9698	1.50605	1.51026	1.52242	1.53273	(47)
C ₈ H ₁₀ OS	α -Butyrothienone.....	17.2	1.0912	1.53747	1.54312*	1.55806	1.57136	(59)
C ₈ H ₁₀ OS	α -Ethyl- α' -acetoethienone.....	16.2	1.0832	1.54576	1.55227*	1.56951	1.58636	(59)
C ₈ H ₁₁ Cl	1, 3-Dimethyl-5-chloro-3, 5-cyclohexadiene.....	15.4	1.0065	1.50022	1.50459	1.51626		(77)
C ₈ H ₁₁ ClO	1, 1-Dimethyl-5-chloro-4-cyclohexen-3-one.....	19.7	1.0841	1.49175	1.49547	1.50550	1.51434	(67)
C ₈ H ₁₁ Cl ₃ O ₃	Ethyl γ , γ , γ -trichloro- β -acetylbutyrate.	14.1	1.3395	1.46224	1.46458	1.47079	1.47612	(81)
C ₈ H ₁₁ ClO ₄	Diethyl chlorofumarate.....	18.3	1.1890	1.45455	1.45782	1.46594	1.47299	(80)
C ₈ H ₁₁ N	Amylpropionic nitrile.....	13	0.8508	1.45247	1.4553	1.46333	1.46952	(150)
C ₈ H ₁₁ N	<i>vic.</i> - <i>o</i> -Xylidine.....	15.3	0.9963	1.56493	1.57063	1.58664	1.60058	(47)
C ₈ H ₁₁ N	<i>m</i> -Xylidine.....	19.6	0.9783	1.55472	1.56066	1.57616	1.59018	(106)
C ₈ H ₁₁ N	<i>asym.</i> - <i>m</i> -Xylidine.....	14.75	0.9786	1.55579	1.56155	1.57748	1.59132	(47)
C ₈ H ₁₁ N	<i>sym.</i> - <i>m</i> -Xylidine.....	12.1	0.9791	1.55622	1.56179	1.57761	1.59140	(47)
C ₈ H ₁₁ N	<i>vic.</i> - <i>m</i> -Xylidine.....	14.05	0.9846	1.55785	1.56347	1.57922	1.59281	(47)
C ₈ H ₁₁ N	<i>p</i> -Xylidine.....	21.3	0.9790	1.55329	1.55914		1.58803	(106)
C ₈ H ₁₁ N	Dimethylaniline.....	20	0.9575	1.55203	1.55873	1.57658	1.59332	(91, 95, 106, † 131)
C ₈ H ₁₁ N	Ethylaniline.....	20.3	0.9620	1.54939	1.55558		1.58631	(106)
C ₈ H ₁₁ NO	1-Methyl-1-cyanocyclohexan-2-one.....	16.1	1.0189	1.45976	1.46239*	1.46820	1.47341	(39)
C ₈ H ₁₁ NO	3-Methyl-1-cyanocyclohexan-2-one.....	15.5	1.0443	1.47084	1.47305*	1.47969	1.48479	(39)
C ₈ H ₁₁ NO	1-Methyl-2, 3-(α , β -tetrahydrobenz)-isoxazole.....	16.2	1.0628	1.48956	1.49262*	1.50031	1.50679	(31)
C ₈ H ₁₁ NO	1-Methyl-2, 3-(β , γ -tetrahydrobenz)-isoxazole.....	13.0	1.0687	1.49206	1.49517*	1.50287	1.50943	(31)
C ₈ H ₁₁ NO ₂	α -Cyano- Δ^4 -isoheptenic acid.....	99.6	0.9715	1.44367	1.44690	1.45599	1.46409	(58)

Formula	Name	t_f , °C	d_4^t	α	D	β	γ	Lit.
$C_8H_{11}NO_3$	Ethyl α -cyano- Δ^1 -pentenate.....	19.9	1.0004	1.44988	1.45292	1.46152	1.46869	(58)
$C_8H_{11}NO_2$	Ethyl α -propiocyanoacetate.....	20	1.0762	1.4567	1.4603	1.4697	1.4780	(138)
$C_8H_{11}NO_3$	Methyl α -butyrocyanoacetate.....	20	1.0933	1.4722	1.4763	1.4871	1.4968	(138)
$C_8H_{11}NO_4$	Diethyl cyanomalonate.....	20	1.0931	1.4240	1.4263	1.4316	1.4362	(138)
C_8H_{12}	$\Delta^{1,3}$ -Dihydro- <i>p</i> -xylene.....	19.5	0.8363	1.47467	1.47888	1.48983	1.49998	(51)
C_8H_{12}	1, 3-Dimethyl-3, 5-cyclohexadiene.....	19.7	0.8189	1.46828	1.47212	1.48214	1.49096	(77)
C_8H_{12}	1, 4-Dimethyl-1, 3-cyclohexadiene.....	16.1	0.8370	1.47787	1.48219	1.49380	1.50459	(43, 54†)
C_8H_{12}	1-Methyl-3-methene-1-cyclohexene.....	17.0	0.8389	1.48274	1.48723	1.49872	1.50910	(44)
$C_8H_{12}ClN$	Dimethylaniline hydrochloride.....	18.5	1.1156	1.56140	1.56619	1.57829	1.58910	(161)
$C_8H_{12}Cl_2O$	1-Methyl-1-dichloromethylcyclohexan-2-one.....	17.5	1.2350	1.49798	1.50076	1.50738	1.51332	(67)
$C_8H_{12}Cl_2O$	1-Methyl-1-dichloromethylcyclohexan-4-one.....	52.8	1.2214	1.49459	1.49775	1.50402	1.50996	(67)
$C_8H_{12}Cl_2O_2$	Suberyl chloride.....	20.6	1.1720	1.46562	1.46847	1.47485	1.48049	(80)
$C_8H_{12}N_2$	2, 5-Dimethyl-3-ethylpyrazine.....	24.0	0.9657	1.49683	1.50136		1.52429	(106)
$C_8H_{12}N_2$	<i>asym.</i> -Ethylphenylhydrazine.....	20.8	1.0181	1.56462	1.57108*	1.58745	1.60262	(29)
$C_8H_{12}N_2$	2-Methyltetrahydroindazole.....	21.5	1.0287	1.51257	1.51619*	1.52520	1.53298	(60)
$C_8H_{12}O$	1, 3-Dimethyl-6-cyclohexen-5-one.....	11.7	0.9462	1.48246	1.48705	1.49633	1.50518	(43)
$C_8H_{12}O$	1-Isopropylene-2-ketocyclopentane.....	20	0.9355	1.46359	1.46660	1.47383	1.47994	(90)
$C_8H_{12}O_2$	Amylpropiolic acid.....	12.6	0.9623	1.46025	1.46335	1.47100	1.47750	(150)
$C_8H_{12}O_2$	Diallylacetic acid.....	21.6	0.9474	1.44774	1.45084	1.45831	1.46442	(71, 125)
$C_8H_{12}O_2$	Δ^1 -Tetrahydro- <i>m</i> -toluic acid.....	69.0	1.0127	1.47283	1.47630*	1.48496		(26)
$C_8H_{12}O_2$	1-Hydroxymethylene-3-methylcyclohexan-2-one.....	15.8	1.0540	1.50072	1.50569	1.52010	1.53435	(56)
$C_8H_{12}O_2$	Ethyl sorbate.....	20.15	0.9560	1.49554	1.50227	1.52001	1.53664	(27, 45†)
$C_8H_{12}O_3$	Acetoxymethylenediethyl ketone.....	18.25	1.0342	1.46116	1.46486	1.47488	1.48438(?)	(17)
$C_8H_{12}O_3$	Ethyl ethylidenecetoacetate.....	18	1.0231	1.44945	1.45283	1.46109	1.46882	(45, † 105)
$C_8H_{12}O_4$	Diethyl fumarate.....	20	1.05199	1.43780	1.44103	1.44902	1.45591	(45, † 144)
$C_8H_{12}O_4$	Diethyl maleate.....	20	1.06917	1.43779	1.44070	1.44763	1.45352	(45, † 144)
$C_8H_{12}O_4$	Ethyl acetoxymethylenecyclopropanone.....	18.6	1.0686	1.44558	1.44903	1.45760	1.46501	(17)
$C_8H_{12}O_4$	Ethyl <i>O</i> -acetylacetoacetate.....	14.95	1.0644	1.44402	1.44695	1.45511	1.46179	(17)
$C_8H_{12}O_4$	Ethyl diacetoacetate.....	18.3	1.0947	1.46512	1.46950	1.48067	1.49125	(17)
$C_8H_{12}O_5$	Diethyl hydroxymethylenemalonate.....	14.25	1.1275	1.45287	1.45605	1.46502	1.47275	(17)
$C_8H_{12}O_5$	Diethyl oxalacetate.....	16.6	1.1715	1.45309	1.45614		1.46993	(105)
$C_8H_{13}N$	Tropidine.....	18.4	0.9535	1.48752	1.49037	1.49793	1.50417	(25)
$C_8H_{13}NO$	Tropinone.....	99.6	0.9872	1.45975	1.46205	1.46910		(25)
$C_8H_{13}NO_2$	2-Cyano- <i>n</i> -heptoic acid.....	17.0	1.0250	1.44686	1.44940*	1.45495	1.45968	(39)
$C_8H_{13}NO_2$	α -Mesityl oxide oxime acetate.....	14	0.9925	1.47379	1.47707*	1.48671	1.49522	(74)
$C_8H_{13}NO_2$	β -Mesityl oxide oxime acetate.....	17.1	0.9922	1.47554	1.47972*	1.48998	1.49852	(74)
C_8H_{14}	1, 1-Dimethyl-3-cyclohexene.....	16.2	0.8056	1.44251	1.44521	1.45182	1.45722	(68)
C_8H_{14}	1, 2-Dimethyl-1-cyclohexene.....	13.5	0.8317	1.45906	1.46178	1.46908	1.47517	(55)
C_8H_{14}	1, 3-Dimethyl-3-cyclohexene.....	22.4	0.8000	1.44263	1.44533	1.45215	1.45795	(55)
C_8H_{14}	1, 3-Dimethyl-4-cyclohexene.....	18.0	0.8102	1.45014	1.45372	1.46078	1.46728	(77)
C_8H_{14}	1, 3-Dimethyl-5-cyclohexene.....	21.1	0.797	1.44086	1.44361	1.45020	1.45587	(55)
C_8H_{14}	1, 4-Dimethyl-1-cyclohexene.....	22	0.7989	1.44112	1.44372	1.45056	1.45626	(55)
C_8H_{14}	Ethenecyclohexane.....	17.6	0.8237	1.46094	1.46389	1.47139	1.47773	(55)
C_8H_{14}	1-Ethyl-1-cyclohexene.....	19.05	0.8238	1.45386	1.45673	1.46347	1.46944	(46)
C_8H_{14}	Ethylidenecyclohexane.....	17.3	0.8244	1.45965	1.46299	1.47010	1.47633	(46)
C_8H_{14}	1-Octene.....	12.5	0.7530	1.4183	1.42075	1.4272	1.4309	(150)
$C_8H_{14}Cl_2$	1-Methyl-1-dichloromethylcyclohexane..	23.7	1.1272	1.48670	1.48947	1.49596	1.50145	(68)
$C_8H_{14}O$	Diallylmethyl carbinol.....	20.6	0.8437	1.43903	1.44172	1.44856	1.45414	(141)
$C_8H_{14}O$	1, 3-Dimethyl-1-cyclohexen-3-ol.....	17.5	0.9327	1.47417	1.47711	1.48458	1.49076	(10)
$C_8H_{14}O$	1, 1-Dimethylcyclohexan-2-one.....	19.9	0.9146	1.44624	1.44863	1.45443	1.45940	(67)
$C_8H_{14}O$	1, 1-Dimethylcyclohexan-3-one.....	18.6	0.9068	1.44513	1.44763	1.45352	1.45851	(67)
$C_8H_{14}O$	1, 1-Dimethylcyclohexan-4-one.....	22.45	0.9280	1.45096	1.45334	1.45941	1.46442	(67)
$C_8H_{14}O$	1, 2-Dimethylcyclohexan-4-one.....	12.6	0.9121	1.44871	1.45094	1.45712	1.46208	(21)
$C_8H_{14}O$	1, 3-Dimethylcyclohexan-2-one.....	11.85	0.9204	1.44976	1.45189	1.45811	1.46252	(62)
$C_8H_{14}O$	1, 3-Dimethylcyclohexan-5-one.....	18.2	0.8933	1.44077	1.44333	1.44916	1.45416	(55)
$C_8H_{14}O_2$	Cyclohexylacetic acid.....	33.5	1.0012	1.45482		1.46303	1.46780	(130)
$C_8H_{14}O_2$	2, 6-Dimethyl- Δ^2 -hexenic acid.....	15.8	0.9360	1.44524	1.44800	1.45514	1.46105	(53)
$C_8H_{14}O_2$	α -Ethyl- Δ^2 -hexenic acid.....	16.5	0.9313	1.44122	1.44364	1.45064	1.45622	(53)
$C_8H_{14}O_2$	Dimethylacetylacetone.....	23.0	0.9336	1.42942	1.43168	1.43758	1.44254	(54)
$C_8H_{14}O_2$	Ethoxymethylene diethyl ketone.....	18.15	0.9446	1.46760	1.47169	1.48289	1.49325(?)	(17)
$C_8H_{14}O_2$	Propylacetylacetone.....	18.2	0.9363	1.43942	1.44369	1.45106	1.45831	(56)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ²⁵	α	D	β	γ	Lit.
C ₈ H ₁₄ O ₂	Ethyl α -ethylcrotonate.....	17.0	0.9106	1.43407	1.43705*	1.44438	1.45069	(69)
C ₈ H ₁₄ O ₂	Ethyl α , β -hexenate.....	20	0.9005	1.43165	1.43474*	1.44200	1.44849	(69)
C ₈ H ₁₄ O ₂	Ethyl α , β -isohexenate.....	18.5	0.8971	1.43043	1.43363*	1.44079	1.44704	(69)
C ₈ H ₁₄ O ₂	Ethyl trimethylacrylate.....	19.3	0.9072	1.42680	1.42987	1.43718	1.44360	(43, † 69)
C ₈ H ₁₄ O ₃	Ethyl cyclopentan-1-ol-1-carboxylate...	16.0	1.0604	1.44897	1.45160	1.45693	1.46171	(63)
C ₈ H ₁₄ O ₃	Ethyl dimethylacetoacetate.....	18.8	0.9771	1.41616	1.41828	1.42358	1.42819	(9)
C ₈ H ₁₄ O ₃	Ethyl ethylacetoacetate.....	16.1	0.9835	1.42147	1.42366	1.42936	1.43434	(9, † 105)
C ₈ H ₁₄ O ₃	Ethyl β -ethoxycrotonate.....	37.6	0.9663	1.44307	1.44678	1.45571	1.46324	(6)
C ₈ H ₁₄ O ₃	Ethyl β -ethoxy- α -methylacrylate.....	21.6	0.9788	1.44649	1.45009	1.45931	1.46760	(5)
C ₈ H ₁₄ O ₄	Diethyl methylmalonate.....	18.7	1.0192	1.41154	1.41369	1.41881	1.42310	(9)
C ₈ H ₁₄ O ₄	Diethyl succinate.....	15.5	1.0454	1.42013	1.42227*	1.42738	1.43160	(73, † 105)
C ₈ H ₁₄ O ₄	Diethyl methylpyrotartrate.....	21.9	1.0285	1.41748	1.41959		1.42897	(102)
C ₈ H ₁₆ Br	1, 3-Dimethylcyclohexyl bromide.....	18.2	1.2074	1.48020	1.48321	1.49033	1.49626	(55)
C ₈ H ₁₆ Cl	1, 2-Dimethylcyclohexyl chloride.....	13.3	0.9708	1.46492	1.46723	1.47407		(21)
C ₈ H ₁₆ Cl	1, 4-Dimethylcyclohexyl chloride.....	18.5	0.9438	1.45088	1.45372	1.45942	1.46462	(21)
C ₈ H ₁₆ N	γ -Coniceine.....	18.4	0.8740	1.45808	1.46068	1.46707	1.47251	(109)
C ₈ H ₁₆ N	Tropine.....	21.6	0.9307	1.47427	1.47659	1.48318	1.48854	(25)
C ₈ H ₁₆ NO	Tropine.....	99.8	1.0161	1.47917	1.48113	1.48766	1.49269	(25)
C ₈ H ₁₆	1, 2-Dimethylcyclohexane.....	17.85	0.7809	1.42820	1.43020	1.43592	1.44056	(21, † 130)
C ₈ H ₁₆	1, 3-Dimethylcyclohexane.....	20.75	0.7707	1.42276	1.42499	1.43047	1.43500	(55)
C ₈ H ₁₆	1, 4-Dimethylcyclohexane.....	15.7	0.7722	1.42407	1.42597	1.43174	1.43624	(21, † 130)
C ₈ H ₁₆	Octylene.....	16.0	0.7256	1.4137	1.4157	1.4222	1.4274	(95, 148 †)
C ₈ H ₁₆ N ₂	Ethylmethylketazine.....	26.6	0.8338	1.44826	1.45160	1.46000	1.46717	(109)
C ₈ H ₁₆ O	Allyldiethyl carbinol.....	21.7	0.8470	1.43853	1.44100	1.44723	1.45235	(141)
C ₈ H ₁₆ O	Allylmethylpropyl carbinol.....	21.3	0.8340	1.43501	1.43758	1.44385	1.44889	(141)
C ₈ H ₁₆ O	1, 1-Dimethylcyclohexan-2-ol.....	22.4	0.9257	1.46404	1.46640	1.47240	1.47735	(67)
C ₈ H ₁₆ O	1, 1-Dimethylcyclohexan-3-ol.....	19.7	0.9089	1.45655	1.45893	1.46476	1.46964	(67)
C ₈ H ₁₆ O	1, 1-Dimethylcyclohexan-4-ol.....	24.7	0.9220	1.45896	1.46128	1.46716	1.47214	(67, † 68)
C ₈ H ₁₆ O	1, 2-Dimethylcyclohexan-2-ol.....	13.7	0.9252	1.46035	1.46248	1.46848	1.47330	(21)
C ₈ H ₁₆ O	1, 2-Dimethylcyclohexan-4-ol.....	12.5	0.9118	1.45826	1.46042	1.46645	1.47121	(21)
C ₈ H ₁₆ O	1, 3-Dimethylcyclohexan-3-ol.....	22.9	0.9028	1.45177	1.45414	1.45984	1.46463	(55)
C ₈ H ₁₆ O	1, 3-Dimethylcyclohexan-5-ol.....	18.55	0.8996	1.45354	1.45601	1.46181	1.46652	(55)
C ₈ H ₁₆ O	1, 4-Dimethylcyclohexan-4-ol.....	23.9	0.9060	1.45317	1.45534	1.46141	1.46622	(55)
C ₈ H ₁₆ O	Methylhexyl ketone.....	20	0.8185	1.41390	1.41613	1.42133	1.42569	(93)
C ₈ H ₁₆ O ₂	<i>cis</i> -Tetramethylbutenediol.....	98.9	0.8693	1.42026	1.42258*	1.42884		(73)
C ₈ H ₁₆ O ₂	<i>trans</i> -Tetramethylbutenediol.....	99.2	0.8634	1.41875	1.42164*	1.42747		(73)
C ₈ H ₁₆ O ₂	Octoic acid.....	21	0.90866	1.42439	1.42677	1.43194	1.43654	(125)
C ₈ H ₁₇ N	Coniine.....	21.9	0.8430	1.44867	1.45119		1.46239	(106, † 157)
C ₈ H ₁₇ N	<i>sym</i> -Copellidine.....	19.0	0.8315	1.44113	1.44354	1.44982	1.45524	(25)
C ₈ H ₁₇ NO	Oenanthaldoxime methyl ether.....	19.4	0.8384	1.42192	1.42431		1.43578	(106)
C ₈ H ₁₇ NO	Isocaproimido ethyl ether.....	17.9	0.8575	1.41766	1.41996	1.42526	1.42957	(109)
C ₈ H ₁₇ NO	Methyl hexylketoxime.....	20.8	0.8845	1.44899	1.45166		1.46339	(106)
C ₈ H ₁₈	Octane.....	17.6	0.7046	1.39677	1.39883	1.40372	1.40781	(129, 148)
C ₈ H ₁₈ N ₂ O	Nitrosodiisobutylamine.....	21.2	0.8915	1.44094	1.44387	1.45147	1.45810	(106)
C ₈ H ₁₈ O	Octyl alcohol.....	9.5		1.4246	1.4279	1.4338	1.4386	(134)
C ₈ H ₁₈ O	Methylhexyl carbinol.....	20	0.8193	1.42231	1.42444	1.42972	1.43397	(93)
C ₈ H ₁₉ N	Diisobutylamine.....	19.6	0.7450	1.40712	1.40934		1.41919	(106)
C ₉ H ₉ N	Phenylpropionic nitrile.....	41.5	1.0046	1.5775	1.58535	1.6068	1.62066	(150)
C ₉ H ₉ ClN	α -Chloroquinoline.....	24.6	1.2464	1.62586	1.63417	1.65650	1.67721	(106)
C ₉ H ₉ O	Phenylpropionic aldehyde.....	12.6	1.0680	1.59745	1.60785	1.63214	1.64930	(150)
C ₉ H ₇ BrO	1-Methyl-4-bromocoumarone.....	34.8	1.4771	1.58473	1.59149	1.60979	1.62638	(23)
C ₉ H ₇ ClO	Cinnamyl chloride.....	42.5	1.1645	1.60451	1.61364	1.64950	1.68531	(80)
C ₉ H ₇ N	Quinoline.....	24.9	1.0895	1.61610	1.62450	1.64702	1.66790	(106, † 134, 145)
C ₉ H ₇ N	Isoquinoline.....	25.1	1.0974	1.61411	1.62233	1.64430	1.66476	(106, † 109, 157)
C ₉ H ₈	Indene.....	12.7	1.01995	1.56454	1.57107	1.58743	1.60220	(161)
C ₉ H ₈ Cl ₄	3, 5-Dichloro-1-methyl-4-(β , β -dichloro-ethyl)-benzene.....	19.0	1.3976	1.56306	1.56784	1.57991	1.59033	(4)
C ₉ H ₈ Cl ₄	3, 5-Dichloro-1-methyl-1-dichloromethyl-4-methene-2, 5-cyclohexadiene.....	16.7	1.4084	1.57462	1.58005	1.59387		(4)
C ₉ H ₈ N ₂	1-Phenylpyrazole.....	14.6	1.1177	1.59160	1.59890*	1.61747	1.63470	(60)
C ₉ H ₈ N ₂	Toluquinoxaline.....	18.4	1.1180	1.61205	1.62112	1.64639	1.67196	(109)
C ₉ H ₈ N ₂ O	2-Acetylmindazole (stable).....	16.8	1.1886	1.58240	1.58955*	1.60812	1.62611	(33)
C ₉ H ₈ O	Cinnamaldehyde.....	20	1.0497	1.60852	1.61949	1.65090	1.68295	(45, † 95)
C ₉ H ₈ O	1-Methylcoumarone.....	14.4	1.0588	1.55479	1.56145	1.57783	1.59297	(23)

Formula	Name	$t, ^\circ\text{C}$	d_4^t	α	D	β	γ	Lit.
$\text{C}_9\text{H}_8\text{O}$	2-Methylcoumarone.....	23.1	1.0543	1.54663	1.55255	1.56824	1.58224	(41)
$\text{C}_9\text{H}_8\text{O}$	4-Methylcoumarone.....	19	1.0605	1.55117	1.55729	1.57300	1.58743	(41)
$\text{C}_9\text{H}_8\text{O}$	α -Hydrindone.....	44.75	1.0938	1.55500	1.56084	1.57655	1.59206	(16)
$\text{C}_9\text{H}_8\text{OS}$	2-Methoxythionaphthene.....	13.6	1.2093	1.61990	1.62767	1.64810		(41)
$\text{C}_9\text{H}_8\text{O}_2$	2-Methoxycoumarone.....	19.3	1.1443	1.55277	1.55894	1.57489	1.58941	(41)
$\text{C}_9\text{H}_8\text{O}_2$	Methylphthalide.....	22	1.1559	1.53918	1.54380	1.55703	1.56828	(145)
$\text{C}_9\text{H}_8\text{O}_2$	1-Methylcoumaranone.....	19.7	1.1531	1.55620	1.56321	1.58288	1.60277	(19)
$\text{C}_9\text{H}_8\text{O}_2$	4-Methylcoumaranone.....	53.8	1.1506	1.55808	1.56521	1.58638		(19)
$\text{C}_9\text{H}_8\text{O}_3$	<i>o</i> -Acetoxybenzaldehyde.....	44.5	1.1580	1.51715	1.52254	1.53646	1.54940	(41)
$\text{C}_9\text{H}_8\text{O}_3$	α -Methoxyphthalide.....	22.8	1.2151	1.53089	1.53522	1.54758	1.55815	(49)
$\text{C}_9\text{H}_8\text{O}_3$	Methyl <i>o</i> -phthalaldehydecaboxylate....	19.6	1.2027	1.53635	1.54143	1.55596	1.56898	(49)
$\text{C}_9\text{H}_8\text{S}$	4-Methylthionaphthene.....	21.65	1.1108	1.60730	1.61476	1.63374	1.65141	(41)
$\text{C}_9\text{H}_9\text{BrO}$	α -Bromopropiophenone.....	19.6	1.4302	1.56617	1.57175	1.58770	1.60204	(15)
$\text{C}_9\text{H}_9\text{BrO}$	1-Methyl-4-bromocoumarane.....	14.4	1.4581	1.56684	1.57270	1.58670	1.59943	(16)
$\text{C}_9\text{H}_9\text{BrO}_2$	Ethyl <i>o</i> -bromobenzoate.....	15.4	1.4438	1.54088	1.54548	1.55837	1.56941	(47)
$\text{C}_9\text{H}_9\text{BrO}_2$	Ethyl <i>m</i> -bromobenzoate.....	18.9	1.4308	1.53836	1.54298	1.55616	1.56729	(47)
$\text{C}_9\text{H}_9\text{BrO}_2$	Ethyl <i>p</i> -bromobenzoate.....	17.3	1.4332	1.54329	1.54829	1.56261	1.57505	(47)
$\text{C}_9\text{H}_9\text{ClO}_2$	Ethyl <i>o</i> -chlorobenzoate.....	15.4	1.1942	1.52044	1.52470	1.53686	1.54717	(47)
$\text{C}_9\text{H}_9\text{ClO}_2$	Ethyl <i>m</i> -chlorobenzoate.....	15.4	1.1859	1.51803	1.52233	1.53454	1.54500	(47)
$\text{C}_9\text{H}_9\text{ClO}_2$	Ethyl <i>p</i> -chlorobenzoate.....	14.0	1.1873	1.52246	1.52700	1.54013	1.55150	(47)
$\text{C}_9\text{H}_9\text{Cl}_3$	5-Chloro-1-methyl-4-(β , β -dichloroethyl)- benzene.....	20.3	1.2874	1.54258	1.55012	1.56130	1.57143	(4)
$\text{C}_9\text{H}_9\text{NO}$	μ -Phenyloxazoline.....	23.4	1.1223	1.55975	1.56554	1.58074	1.59429	(106)
C_9H_{10}	Hydrindene.....	16.4	0.96250	1.53394	1.53877	1.55114	1.56136	(161)
C_9H_{10}	<i>o</i> -Methylstyrene.....	14.1	0.9155	1.54175	1.54765	1.56444	1.57904	(14)
C_9H_{10}	<i>p</i> -Methylstyrene.....	16.4	0.9003	1.53811	1.54465	1.56200	1.57784	(8)
C_9H_{10}	α -Methylstyrene.....	19.8	0.9078	1.52893	1.53492	1.54959	1.56284	(43)
C_9H_{10}	β -Methylstyrene.....	18.7	0.9145	1.54257	1.54967	1.56600	1.58103	(43)
$\text{C}_9\text{H}_{10}\text{Cl}_2\text{O}$	1, 3-Dimethyl-1-dichloromethyl-2, 5- cyclohexadien-4-one.....	20.5	1.2405	1.53960	1.54379	1.55613	1.56675	(89)
$\text{C}_9\text{H}_{10}\text{Cl}_2\text{O}$	1, 5-Dimethyl-1-dichloromethyl-3, 5-cy- clohexadien-2-one.....	19.8	1.2250	1.52906	1.53366	1.54766		(88)
$\text{C}_9\text{H}_{10}\text{N}_2$	1-Ethylindazole.....	14.7	1.0678	1.56918	1.57577*	1.59267	1.60856	(60)
$\text{C}_9\text{H}_{10}\text{N}_2$	2-Ethylindazole.....	16.2	1.0768	1.58564	1.59310*	1.61238	1.63081	(60)
$\text{C}_9\text{H}_{10}\text{O}$	<i>o</i> -Allylphenol.....	14.25	1.0262	1.54290	1.54853	1.56164	1.57345	(47)
$\text{C}_9\text{H}_{10}\text{O}$	Cinnamyl alcohol.....	20	1.0440	1.57510	1.58190	1.59993	1.61631	(43, † 95, 132, 155, 156)
$\text{C}_9\text{H}_{10}\text{O}$	<i>o</i> -Propenylphenol.....	14.25	1.0438	1.57670	1.58368	1.60310	1.62110	(14)
$\text{C}_9\text{H}_{10}\text{O}$	Ethyl phenyl ketone.....	15.9	1.0134	1.52375	1.52900	1.54223	1.55403	(8)
$\text{C}_9\text{H}_{10}\text{O}$	<i>o</i> -Methylacetophenone.....	12.75	1.0203	1.52963	1.53522	1.54885	1.56134	(41)
$\text{C}_9\text{H}_{10}\text{O}$	<i>m</i> -Methylacetophenone.....	15.3	1.0108	1.52697	1.53270	1.54654	1.55946	(41)
$\text{C}_9\text{H}_{10}\text{O}$	<i>p</i> -Methylacetophenone.....	17.4	1.0061	1.52976	1.53533	1.55018	1.56369	(8)
$\text{C}_9\text{H}_{10}\text{O}$	<i>o</i> -Methoxystyrene.....	17.4	1.0047	1.55016	1.55701	1.57526	1.59233	(14)
$\text{C}_9\text{H}_{10}\text{O}$	α -Methoxystyrene.....	25.0	0.9936	1.53402	1.53997	1.55521	1.56918	(5)
$\text{C}_9\text{H}_{10}\text{O}$	β -Methoxystyrene.....	24.3	0.9886	1.55467	1.56197	1.58139	1.59962	(5)
$\text{C}_9\text{H}_{10}\text{O}$	1'-Methyl-2-hydroxystyrene.....	18.5	1.0296	1.54328	1.54904	1.56368	1.57699	(14)
$\text{C}_9\text{H}_{10}\text{O}$	1'-Methyl-3-hydroxystyrene.....	13.0	1.0476	1.56721	1.57337	1.59064	1.60612	(14)
$\text{C}_9\text{H}_{10}\text{O}$	Chavicol.....	18	1.033	1.5393	1.5441	1.5573	1.6689	(128)
$\text{C}_9\text{H}_{10}\text{O}$	Chromane.....	14.1	1.0697	1.54601	1.55063	1.56376	1.57526	(16)
$\text{C}_9\text{H}_{10}\text{O}$	1-Methylcoumarane.....	13.7	1.0363	1.52919	1.53375	1.54678	1.55800	(16)
$\text{C}_9\text{H}_{10}\text{O}$	4-Methylcoumarane.....	18.6	1.0463	1.53521	1.54044	1.55351	1.56537	(16)
$\text{C}_9\text{H}_{10}\text{O}_2$	<i>o</i> -Methoxy- <i>m</i> -toluic aldehyde.....	19.2	1.0988	1.54672	1.55375	1.57328		(41)
$\text{C}_9\text{H}_{10}\text{O}_2$	2-Hydroxy-5-methylacetophenone.....	53	1.0797	1.53426	1.54095	1.56135		(41)
$\text{C}_9\text{H}_{10}\text{O}_2$	α -Hydroxypropiophenone.....	22.8	1.1044	1.53104	1.53558	1.54873		(15)
$\text{C}_9\text{H}_{10}\text{O}_2$	<i>o</i> -Methoxyacetophenone.....	23.6	1.0850	1.53214	1.53787	1.55339	1.56792	(41)
$\text{C}_9\text{H}_{10}\text{O}_2$	<i>m</i> -Methoxyacetophenone.....	15.35	1.0993	1.53693	1.54313	1.55829	1.57247	(41)
$\text{C}_9\text{H}_{10}\text{O}_2$	<i>p</i> -Methoxyacetophenone.....	41.3	1.0816	1.53998	1.54684	1.56443	1.58094	(41)
$\text{C}_9\text{H}_{10}\text{O}_2$	<i>o</i> -Ethylbenzoic acid.....	99.6	1.0420	1.50559	1.51012	1.52333	1.53455	(145)
$\text{C}_9\text{H}_{10}\text{O}_2$	Ethyl benzoate.....	17.3	1.0496	1.50179	1.50682	1.51839	1.52854	(43)
$\text{C}_9\text{H}_{10}\text{O}_3$	Ethyl salicylate.....	14.4	1.1355	1.51977	1.52511	1.54036	1.55466	(41)
$\text{C}_9\text{H}_{10}\text{O}_3$	Methyl <i>o</i> -methoxybenzoate.....	19.5	1.1566	1.52893	1.53422	1.54789	1.56029	(41)
$\text{C}_9\text{H}_{11}\text{BrO}$	2-Ethoxy-4-bromotoluene.....	11.35	1.3592	1.54387	1.54858	1.56186	1.57332	(16)
$\text{C}_9\text{H}_{11}\text{I}$	<i>sym</i> -Iodopseudocumene.....	65.3	1.5113	1.57573	1.58129	1.59673		(47)
$\text{C}_9\text{H}_{11}\text{N}$	2-Dihydromethylindole.....	23.4	1.0197	1.56264	1.56868		1.59979	(106)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ^t	α	D	β	γ	Lit.
C ₉ H ₁₁ N	Tetrahydroisoquinoline.....	23.1	1.0642	1.57418	1.57982		1.60681	(106)
C ₉ H ₁₁ N	Tetrahydroquinoline.....	23.9	1.0546	1.58675	1.59331	1.61093	1.62721	(106)
C ₉ H ₁₁ NO	α -Benzaldoxime ethyl ether.....	21.7	0.9918	1.52880	1.53498	1.55126	1.56628	(106)
C ₉ H ₁₁ NO ₂	<i>o</i> -Anisaldoxime methyl ether.....	18.6	1.0934	1.54784	1.55505*	1.57405	1.59287	(31)
C ₉ H ₁₂	1, 1-Dimethyl-4-methene-2, 5-cyclohexa- diene.....	15.8	0.8360	1.49799	1.50295	1.51739	1.53009	(89)
C ₉ H ₁₂	Isopropylbenzene.....	16.8	0.8662	1.49063	1.49441	1.50539	1.51466	(20, † 148)
C ₉ H ₁₂	Mesitylene.....	17.1	0.8646	1.49403	1.49804	1.50936	1.51891	(20, † 75, 92, 148)
C ₉ H ₁₂	<i>o</i> -Methylethylbenzene.....	16.05	0.8831	1.50148	1.50569	1.51697	1.52653	(16, 20 †)
C ₉ H ₁₂	<i>m</i> -Methylethylbenzene.....	19.9	0.8669	1.49575	1.49966	1.51102	1.52056	(20, 61 †)
C ₉ H ₁₂	<i>p</i> -Methylethylbenzene.....	22.8	0.8597	1.48921	1.49303	1.50417	1.51353	(20, † 61, 145)
C ₉ H ₁₂	Propylbenzene.....	12.25	0.8681	1.49176	1.49549	1.50630	1.51533	(20, † 148)
C ₉ H ₁₂	Pseudocumene.....	15.3	0.8794	1.50259	1.50672	1.51841	1.52816	(20, † 105, 148)
C ₉ H ₁₂	1, 2, 3-Trimethylbenzene.....	19.55	0.8949	1.50930	1.51335	1.52503	1.53483	(20)
C ₉ H ₁₂ Cl ₂ O	1, 4-Dimethyl-4-dichloromethyl-1-cyclo- hexen-3-one.....	45.8	1.2067	1.51125	1.51508	1.52494	1.53365	(52)
C ₉ H ₁₂ N ₂ O	2-Acetyltetrahydroindazole.....	24.0	1.1148	1.52635	1.53098*	1.54227	1.55266	(60)
C ₉ H ₁₂ O	<i>o</i> -Ethoxytoluene.....	13.3	0.9592	1.50383	1.50791	1.51974	1.52987	(16, 47)
C ₉ H ₁₂ O	<i>m</i> -Ethoxytoluene.....	11.7	0.9558	1.50507	1.50920	1.52112	1.53112	(47)
C ₉ H ₁₂ O	<i>p</i> -Ethoxytoluene.....	17.6	0.9509	1.50175	1.50582	1.51749	1.52793	(47)
C ₉ H ₁₂ O	<i>asym.</i> -Methoxy- <i>m</i> -xylene.....	12.85	0.9696	1.51298	1.51730	1.52967	1.54023	(16)
C ₉ H ₁₂ O	Benzylmethyl carbinol.....	14.5	0.9988	1.52017	1.52425	1.53453	1.54355	(57)
C ₉ H ₁₂ O	Phenylpropyl alcohol.....	20	1.0079	1.53101	1.53565	1.54782	1.55829	(92)
C ₉ H ₁₂ O	<i>m</i> -Tolylmethyl carbinol.....	15.35	0.9973	1.52262	1.52635	1.53740	1.54710	(41)
C ₉ H ₁₂ O	<i>p</i> -Tolylmethyl carbinol.....	18.4	1.0045	1.52880	1.53391	1.54835	1.56127	(61)
C ₉ H ₁₂ O	<i>asym.</i> - <i>o</i> -Xylenyl methyl ether.....	13.7	0.9744	1.51545	1.51980	1.53194	1.54249	(47)
C ₉ H ₁₂ O	<i>vic.</i> - <i>o</i> -Xylenyl methyl ether.....	39.7	0.9596	1.50786	1.51197	1.52418	1.53434	(47)
C ₉ H ₁₂ O	<i>asym.</i> - <i>m</i> -Xylenyl methyl ether.....	12.85	0.9696	1.51298	1.51730	1.52967	1.54023	(16, † 47)
C ₉ H ₁₂ O	<i>sym.</i> - <i>m</i> -Xylenyl methyl ether.....	15.1	0.9627	1.51056	1.51485	1.52695	1.53730	(47)
C ₉ H ₁₂ O	<i>vic.</i> - <i>m</i> -Xylenyl methyl ether.....	13.6	0.9619	1.50148	1.50533	1.51666	1.52610	(47)
C ₉ H ₁₂ O	<i>p</i> -Xylenyl methyl ether.....	12.8	0.9693	1.51388	1.51818	1.53057	1.54106	(47)
C ₉ H ₁₂ OS	α -Isovalerothienone.....	14.4	1.0677	1.53246	1.53803*	1.55238	1.56627	(59)
C ₉ H ₁₂ OS	α -Propyl- α' -acetothienone.....	14.6	1.0663	1.54079	1.54710*	1.56368	1.57997	(59)
C ₉ H ₁₂ O ₂	<i>o</i> -Hydroxydihydrocinnamyl alcohol....	15.0	1.1259	1.55121	1.55576	1.56805	1.57881	(16)
C ₉ H ₁₂ O ₂	1, 4-Dimethyl-1, 3-cyclohexadien-3- carboxylic acid.....	18.5	1.0446	1.49024	1.49384	1.50331	1.51158	(54)
C ₉ H ₁₂ O ₃	Acetoxymethylencyclohexanone.....	15.6	1.1152	1.49537	1.49936	1.51041		(17)
C ₉ H ₁₂ O ₄	Dimethyl isoprenedicarboxylate.....	42.7	1.0964	1.49870	1.50482*	1.52115	1.53691	(27)
C ₉ H ₁₃ BrO ₅	Diethyl α -bromoacetylmalonate.....	18.1	1.3905	1.45777	1.46024	1.46712	1.47283	(34)
C ₉ H ₁₃ ClO ₅	Diethyl α -chloroacetylmalonate.....	12.25	1.1948	1.44243	1.44456	1.45073	1.45573	(34)
C ₉ H ₁₃ Cl ₃ O	1, 1, 1-Trichloro-2-hydroxy-3-nonine....	9.9	1.2342	1.49695	1.5000	1.50735	1.51216	(150)
C ₉ H ₁₃ N	Dimethyl- <i>o</i> -toluidine.....	23.3	0.9250	1.51932	1.52437		1.54841	(106)
C ₉ H ₁₃ N	Dimethyl- <i>p</i> -toluidine.....	20.2	0.9366	1.54061	1.54686		1.57784	(106)
C ₉ H ₁₃ N	Hexylpropionic nitrile.....	14.4	0.8493	1.45344	1.45637	1.46410	1.46977	(150)
C ₉ H ₁₃ NO	1-Ethyl-1-cyanocyclohexan-2-one.....	13.6	1.0136	1.46619	1.46851	1.47476	1.47980	(39)
C ₉ H ₁₃ NO	1-Cyano-2-ethoxy-1-cyclohexene.....	13.9	1.0243	1.49320	1.49657	1.50627		(39)
C ₉ H ₁₃ NO ₃	Ethyl α -butyro- α -cyanoacetate.....	20	1.0561	1.4577	1.4614	1.4706	1.4789	(138)
C ₉ H ₁₃ NO ₃	Ethyl α -isobutyro- α -cyanoacetate.....	20	1.0542	1.4570	1.4606	1.4699	1.4782	(138)
C ₉ H ₁₃ NO ₄	Diethyl methylecyanomalonate.....	20	1.0695	1.4209	1.4232	1.4282	1.4324	(138)
C ₉ H ₁₄	1-Methyl-4-ethyl-1, 3-cyclohexadiene...	19.4	0.8371	1.47828	1.48250	1.49353	1.50422	(43, 52 †)
C ₉ H ₁₄ Cl ₂	1, 4-Dimethyl-1-dichloromethyl-3-cyclo- hexene.....	23	1.1227	1.49622	1.49913	1.50650	1.51275	(68)
C ₉ H ₁₄ N ₂	2, 7-Dimethyltetrahydroindazole.....	19.1	1.0126	1.50872	1.51233*	1.52099	1.52848	(60)
C ₉ H ₁₄ O	<i>asym.</i> -Diallylacetone.....	20.9	0.8591	1.44322	1.44622	1.45363	1.45991	(71)
C ₉ H ₁₄ O	<i>sym.</i> -Diallylacetone.....	14.0	0.8684	1.44752	1.45041	1.45789	1.46418	(71, † 125)
C ₉ H ₁₄ O	Phorone.....	20	0.8850	1.49393	1.49982	1.51527		(95)
C ₉ H ₁₄ O	α , β -Pulonenone.....	16.5	0.9317	1.47613	1.47958	1.48884	1.49688	(43, † 50)
C ₉ H ₁₄ O	β , γ -Pulenenone.....	17.7	0.9055	1.45305	1.45582	1.46277	1.46866	(50)
C ₉ H ₁₄ O	1, 1, 3-Trimethyl-2-cyclohexen-4-one....	16.3	0.9332	1.47622	1.47951	1.48857	1.49645	(21)
C ₉ H ₁₄ O ₂	α -Cyclohexenepropionic acid.....	20.3	1.0099	1.47240	1.47526	1.48253	1.48871	(46)
C ₉ H ₁₄ O ₂	Hexylpropionic acid.....	12.5	0.9525	1.4611	1.46429	1.4715	1.4777	(150)
C ₉ H ₁₄ O ₂	2-Methylcyclohexeneacetic acid.....	15.8	1.0277	1.47896	1.48170			(46)
C ₉ H ₁₄ O ₂	3-Methylcyclohexeneacetic acid.....	15.4	1.0273	1.47935	1.48239	1.48953	1.49515	(46)

Formula	Name	$t, ^\circ\text{C}$	d_4^t	α	D	β	γ	Lit.
$\text{C}_9\text{H}_{14}\text{O}_2$	1-Hydroxymethylene-4, 5-dimethyl-cyclohexan-2-one.....	15.9	1.0257	1.49489	1.49950	1.51278	1.52562	(56)
$\text{C}_9\text{H}_{14}\text{O}_2$	Ethoxymethylenecyclohexanone.....	10.8	1.0291	1.49615	1.50019	1.51161	1.52218	(17)
$\text{C}_9\text{H}_{14}\text{O}_2$	Ethyl α -methylsorbate.....	16.5	0.9501	1.49306	1.49907*	1.51492	1.52998	(27)
$\text{C}_9\text{H}_{14}\text{O}_2$	Ethyl γ -methylsorbate.....	15.6	0.9499	1.49484	1.50087*	1.51642	1.53138	(27)
$\text{C}_9\text{H}_{14}\text{O}_2$	Ethyl Δ^1 -tetrahydrobenzoate.....	14.15	1.0032	1.46793	1.47167*	1.47885	1.48558	(26)
$\text{C}_9\text{H}_{14}\text{O}_2$	Methyl amylpropiolate.....	12.3	0.9335	1.4477	1.45092	1.4579	1.4635	(150)
$\text{C}_9\text{H}_{14}\text{O}_2$	Methyl cyclohexeneacetate.....	18.2	1.0032	1.46561	1.46871	1.47558	1.48165	(46)
$\text{C}_9\text{H}_{14}\text{O}_2$	Methyl cyclohexylideneacetate.....	19.7	0.9989	1.47916	1.48308	1.49187	1.49959	(46)
$\text{C}_9\text{H}_{14}\text{O}_3$	Acetoxymethylenemethyl- <i>tert</i> -butyl ketone.....	53.3	0.9645	1.44122	1.44434	1.45359	1.46226(?)	(17)
$\text{C}_9\text{H}_{14}\text{O}_3$	Ethyl allylacetate.....	17.6	0.9922	1.43602	1.43875		1.45031	(105)
$\text{C}_9\text{H}_{14}\text{O}_3$	Ethyl isopropylideneacetate.....	19.9		1.44915	1.45233	1.46024	1.46729	(45)
$\text{C}_9\text{H}_{14}\text{O}_4$	Diethyl citraconate.....	20	1.0624	1.44380	1.44693	1.45439	1.46098	(45, † 144)
$\text{C}_9\text{H}_{14}\text{O}_4$	Diethyl itaconate.....	20	1.0461	1.43614	1.43884	1.44532	1.45082	(44, 144)
$\text{C}_9\text{H}_{14}\text{O}_4$	Diethyl mesaconate.....	20	1.04674	1.44599	1.44931	1.45751	1.46460	(45, † 144)
$\text{C}_9\text{H}_{14}\text{O}_4$	Diethyl ethylidenemalonate.....	16.1	1.0426	1.43798	1.44084	1.44785	1.45393	(45)
$\text{C}_9\text{H}_{14}\text{O}_4$	Ethyl ethoxymethyleneacetate.....	16.9	1.0709	1.47210	1.47623	1.48710	1.49708	(17)
$\text{C}_9\text{H}_{14}\text{O}_4$	Ethyl acetoneoxalate <i>O</i> -ethyl ether.....	15.3	1.0644	1.46655	1.47103	1.48316	1.49452	(42)
$\text{C}_9\text{H}_{14}\text{O}_6$	Diethyl acetonedicarboxylate.....	23.6	1.1071	1.43529	1.43775		1.44936	(105)
$\text{C}_9\text{H}_{14}\text{O}_6$	Diethyl acetylmalonate.....	14.2	1.1051	1.44574	1.44860	1.45692	1.46411	(56, † 105)
$\text{C}_9\text{H}_{14}\text{O}_6$	Ethyl β -hydroxycarbethoxy- α , β -crotonate.....	23.9	1.0890	1.43808	1.44097	1.44809	1.45414	(43, † 105)
$\text{C}_9\text{H}_{14}\text{S}$	α -Isoamylthiophene.....	11.8	0.9481	1.49750	1.50144*	1.51096	1.51930	(59)
$\text{C}_9\text{H}_{15}\text{ClO}$	α , β -Nonylenyl chloride.....	19.2	0.9675	1.45738	1.46075*	1.46876	1.47608	(69)
$\text{C}_9\text{H}_{15}\text{N}$	α , β -Nonylenic nitrile.....	15.1	0.8365	1.44454	1.44758*	1.45483	1.46096	(69)
$\text{C}_9\text{H}_{15}\text{NO}$	Pseudopelletierine.....	99.5	1.0014	1.47351	1.47596	1.48289	1.48861	(25)
C_9H_{16}	1, 3-Dimethyl-5-methenecyclohexane....	14.6	0.7918	1.44334	1.44628	1.45313	1.45917	(55)
C_9H_{16}	1-Isopropyl-1-cyclohexene.....	15.2	0.8320	1.45884	1.46150	1.46851	1.47436	(46)
C_9H_{16}	Isopropylidenecyclohexane.....	15.8	0.8398	1.47181	1.47466	1.48203	1.48869	(46)
C_9H_{16}	Geraniolene.....	21.5	0.7680	1.44222	1.44532	1.45324	1.45912	(71)
C_9H_{16}	1, 1, 2-Trimethyl-2-cyclohexene.....	20.4	0.8216	1.45336	1.45603	1.46298	1.46877	(68)
C_9H_{16}	1, 1, 4-Trimethyl-3-cyclohexene.....	23.15	0.8021	1.44152	1.44422	1.45086	1.45652	(68)
C_9H_{16}	1, 2, 3-Trimethyl-1-cyclohexene.....	11.75	0.8347	1.46015	1.46296	1.47021	1.47603	(62)
C_9H_{16}	1, 2, 5-Trimethyl-4-cyclohexene.....	16.15	0.8078	1.44742	1.44990	1.45683	1.46264	(21)
C_9H_{16}	1, 3, 5-Trimethylcyclohexene.....	24.7	0.7941	1.44102	1.44378	1.45057	1.45638	(55)
$\text{C}_9\text{H}_{16}\text{Br}_2$	1, 1, 4-Trimethyl-3, 4-dibromocyclohexane.....	18.7	1.5320	1.52474	1.52805	1.53642	1.54354	(68)
$\text{C}_9\text{H}_{16}\text{O}$	1, 1, 3-Trimethylcyclohexan-4-one.....	16.45	0.9045	1.44907	1.45130	1.45732	1.46240	(21)
$\text{C}_9\text{H}_{16}\text{O}$	1, 2, 5-Trimethylcyclohexan-4-one.....	17.4	0.8989	1.44797	1.45010	1.45618	1.46112	(21)
$\text{C}_9\text{H}_{16}\text{O}$	1, 3, 5-Trimethyl-3-cyclohexen-5-ol....	21.5	0.9140	1.46995	1.47251	1.47999	1.48608	(75)
$\text{C}_9\text{H}_{16}\text{O}$	β , γ -Pulnenol.....	18.5	0.9209	1.47113	1.47398	1.48116	1.48715	(50)
$\text{C}_9\text{H}_{16}\text{O}_2$	α , β -Nonylenic acid.....	15.6	0.9334	1.45267	1.45581*	1.46318	1.46956	(69)
$\text{C}_9\text{H}_{16}\text{O}_2$	Ethoxymethylenemethyl <i>tert</i> -butyl ketone.....	14.2	0.9158	1.45697	1.46048	1.47052	1.47951(?)	(17)
$\text{C}_9\text{H}_{16}\text{O}_2$	Ethyl α , β -isoheptenate.....	15.2	0.8930	1.43538	1.43845*	1.44576	1.45226	(69)
$\text{C}_9\text{H}_{16}\text{O}_3$	β -Amyl- β -methoxyacrylic acid.....	60.8	0.9688	1.45506	1.45876	1.46841		(17)
$\text{C}_9\text{H}_{16}\text{O}_3$	β , β -Dimethyl- δ -acetylvaleric acid....	14.3	1.0374	1.45646	1.45894	1.46516		(68)
$\text{C}_9\text{H}_{16}\text{O}_3$	Ethyl methylethylacetate.....	18.7	0.9732	1.42399	1.42617	1.43154	1.43619	(9)
$\text{C}_9\text{H}_{16}\text{O}_4$	Azelaic acid.....	110.6	1.0291	1.42807		1.43576	1.44015	(130)
$\text{C}_9\text{H}_{16}\text{O}_4$	Diethyl dimethylmalonate.....	24.1	0.9917	1.40842	1.41049	1.41554	1.41972	(9)
$\text{C}_9\text{H}_{16}\text{O}_4$	Dimethyl diethylmalonate.....	24.5	1.0312	1.42330	1.42528	1.43052	1.43488	(9)
$\text{C}_9\text{H}_{16}\text{O}_4$	Diethyl pyrotartrate.....	19.8	1.0110	1.41717	1.41938*	1.42434	1.42857	(73, † 102)
$\text{C}_9\text{H}_{17}\text{Br}$	1, 1, 4-Trimethyl-4-bromocyclohexane..	17.4	1.1700	1.47721	1.47995	1.48710	1.49311	(68)
$\text{C}_9\text{H}_{17}\text{Br}$	1, 3, 5-Trimethylcyclohexyl-1-bromide..	11.1	1.1749	1.47951	1.48280	1.48971	1.49532	(55)
$\text{C}_9\text{H}_{17}\text{Cl}$	1, 3, 5-Trimethylcyclohexyl-1-chloride..	15.2	0.9219	1.45182	1.45455	1.46035	1.46555	(55)
$\text{C}_9\text{H}_{17}\text{Cl}$	1, 3, 5-Trimethylcyclohexyl-5-chloride..	13.9	0.9342	1.45566	1.45775	1.46412	1.46925	(21)
C_9H_{18}	1-Methyl-3-isopropylcyclopentane.....	15.2	0.7799	1.42744		1.43505	1.43947	(130)
C_9H_{18}	1, 1, 3-Trimethylcyclohexane.....	25.3	0.7866	1.43177	1.43385	1.43998	1.44453	(21)
C_9H_{18}	1, 2, 4-Trimethylcyclohexane.....	16.7	0.7848	1.43054		1.43829	1.44281	(130)
C_9H_{18}	1, 2, 5-Trimethylcyclohexane.....	16.9	0.7799	1.42860	1.43056	1.43632	1.44099	(21)
C_9H_{18}	1, 3, 5-Trimethylcyclohexane.....	13.1	0.7777	1.42971	1.43175	1.43764	1.44235	(21)
$\text{C}_9\text{H}_{18}\text{O}$	2, 6-Dimethyl-2-hepten-6-ol.....	17.6	0.8449	1.44633	1.44892	1.45572	1.46135	(71)
$\text{C}_9\text{H}_{18}\text{O}$	1-Isopropylcyclohexanol.....	15.5	0.9142	1.46064	1.46419	1.46891	1.47387	(46)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ^t	α	D	β	γ	Lit.
C ₉ H ₁₈ O	Pulenenol.....	16.5	0.9082	1.46064	1.46319	1.46961	1.47486	(50)
C ₉ H ₁₈ O	1, 1, 2-Trimethylcyclohexan-2-ol.....	19.9	0.9258	1.46542	1.46788	1.47367	1.47862	(67)
C ₉ H ₁₈ O	1, 2, 5-Trimethylcyclohexan-4-ol.....	19.2	0.8988	1.45639	1.45851	1.46459	1.46938	(21)
C ₉ H ₁₈ O	1, 3, 5-Trimethylcyclohexan-5-ol.....	16.3	0.8880	1.45108	1.45371	1.45921	1.46422	(55)
C ₉ H ₁₈ O ₄	Ethyl α, α-diethoxypropionate.....	17.1	0.9792	1.41314	1.41508	1.42001	1.42419	(5)
C ₉ H ₁₈ S ₃	Trithioacetone.....	23.5	1.0647	1.53634	1.54026*	1.54970		(73)
C ₉ H ₁₉ N	α-Isobutylpiperidine.....	21.7	0.8510	1.45274	1.45534	1.46158	1.46681	(106)
C ₉ H ₁₉ N	N-Methyl-sym.-copellidine.....	19.7	0.8231	1.44063	1.44299	1.44952	1.45471	(25)
C ₉ H ₁₉ NO ₂	Ethyl <i>n</i> -hexylcarbamate.....	26.8	0.9226	1.43176	1.43412	1.43966	1.44416	(109)
C ₉ H ₂₀ O ₄	Tetraethyl orthocarbonate.....	16.55	0.9198	1.39334	1.39518*	1.39954	1.40324	(28, † 108)
C ₉ H ₂₁ N	Tripropylamine.....	19.4	0.7573	1.41515	1.41756		1.42814	(106, 132)
C ₉ H ₂₁ N ₃	Triformalethylamine.....	20.2	0.8941	1.45758	1.46044	1.46716	1.47287	(109)
C ₁₀ H ₆ Cl ₂	1, 2-Dichloronaphthalene.....	48.5	1.3147	1.62571	1.63375	1.65620	1.67720	(48)
C ₁₀ H ₆ Cl ₂	1, 4-Dichloronaphthalene.....	75.9	1.2997	1.61508	1.62282	1.64541	1.66589	(48)
C ₁₀ H ₆ Cl ₂	1, 7-Dichloronaphthalene.....	99.5	1.2611	1.60165	1.60921	1.63070	1.64954	(145)
C ₁₀ H ₆ Cl ₂	1, 8-Dichloronaphthalene.....	99.8	1.2924	1.61545	1.62357	1.64675	1.66555	(145)
C ₁₀ H ₇ Br	1-Bromonaphthalene.....	19.4	1.4868	1.64995	1.65876	1.68245	1.70433	(48, 111, † 112, 132)
C ₁₀ H ₇ Cl	1-Chloronaphthalene.....	21.6	1.1906	1.62365	1.63184	1.65456	1.67521	(48)
C ₁₀ H ₇ Cl	2-Chloronaphthalene.....	70.7	1.1377	1.60015	1.60787	1.62966		(48)
C ₁₀ H ₇ ClO ₃	1-Phenyl-3-hydroxy-4, 4, 4-trichloro-1-butine.....	9.5	1.3541	1.58585	1.5917	1.60708	1.6176	(150)
C ₁₀ H ₇ I	1-Iodonaphthalene.....	14	1.7474	1.69547	1.70540	1.73295		(145)
C ₁₀ H ₇ I	2-Iodonaphthalene.....	99.4	1.6319	1.65665	1.66617	1.69264		(145)
C ₁₀ H ₈	Naphthalene.....	99.6	0.9645	1.57472	1.58218	1.60328	1.62261	(48, 145 †)
C ₁₀ H ₈ O ₂	Methyl phenylpropiolate.....	30.5	1.0768		1.56006	1.5786	1.5952	(150)
C ₁₀ H ₉ ClN ₂	1-Phenyl-5-methyl-3-chloropyrazole....	15.3	1.2106	1.58046	1.58653*	1.60159	1.61512	(60)
C ₁₀ H ₉ ClN ₂	1-Phenyl-3-methyl-5-chloropyrazole....	16.2	1.1971	1.57516	1.58127*	1.59650	1.61021	(60)
C ₁₀ H ₉ ClO ₂	1, 4-Dimethyl-1-chlorocoumaranone....	18.65	1.2189	1.54953	1.55580	1.57465	1.59368	(19)
C ₁₀ H ₉ ClO ₂	2, 2-Dimethyl-5-chlorocoumaranone....	99.6	1.1484	1.51605	1.52238*	1.53943	1.55718	(40)
C ₁₀ H ₉ N	α-Methylquinoline.....	25.4	1.0536	1.60116	1.60909	1.63025	1.65024	(106)
C ₁₀ H ₉ N	γ-Methylquinoline.....	23.3	1.0709	1.59919	1.60695	1.62756	1.64664	(109)
C ₁₀ H ₉ N	α-Methylisoquinoline.....	20.5	1.0763	1.60173	1.60946	1.63009	1.64914	(109)
C ₁₀ H ₉ N	2-Naphthylamine.....	98.4	1.0614	1.63886	1.64927	1.67960	1.70193	(161)
C ₁₀ H ₉ N	<i>o</i> -Toluquinoline.....	20.8	1.0722	1.60810	1.61616	1.63773	1.65765	(109)
C ₁₀ H ₉ N	<i>m</i> -Toluquinoline.....	20.8	1.0670	1.60676	1.61486	1.63657	1.65677	(109)
C ₁₀ H ₉ N	<i>p</i> -Toluquinoline.....	23.0	1.0634	1.60608	1.61410	1.63584	1.65607	(109)
C ₁₀ H ₁₀	Δ ¹ -Dihydronaphthalene.....	18.3	0.9976	1.57637	1.58317	1.60088	1.61720	(10)
C ₁₀ H ₁₀	Δ ² -Dihydronaphthalene.....	32.7	0.9928	1.54992	1.55489	1.56752	1.57866	(10)
C ₁₀ H ₁₀	γ-Methylindene.....	27	0.9682	1.55319	1.55907	1.57460	1.58865	(98)
C ₁₀ H ₁₀	1-Phenylbutadiene.....	16	0.9309	1.60345	1.61283	1.64231	1.67190	(45, † 142)
C ₁₀ H ₁₀ N ₂	1-Allylindazole.....	17.8	1.0687	1.57563	1.58246*	1.59964	1.61569	(60)
C ₁₀ H ₁₀ N ₂	2-Allylindazole.....	15.0	1.0793	1.59298	1.60054*	1.62016	1.63876	(60)
C ₁₀ H ₁₀ N ₂	1-Phenyl-5-methylpyrazole.....	12.4	1.0936	1.57925	1.58550*	1.60120	1.61534	(60)
C ₁₀ H ₁₀ N ₂ O	2-Acetyl-6-methylindazole.....	4.95	1.1623	1.57984	1.58676*	1.60479	1.62177	(33)
C ₁₀ H ₁₀ N ₂ O ₂	Ethyl indazole-2-carboxylate.....	13.2	1.2060	1.56324	1.56939*	1.58514	1.59960	(29)
C ₁₀ H ₁₀ O	1, 4-Dimethylcoumarone.....	15.5	1.0346	1.54964	1.55537	1.57176	1.58632	(23)
C ₁₀ H ₁₀ O	1, 6-Dimethylcoumarone.....	14.4	1.0414	1.55061	1.55708	1.57261	1.58700	(23)
C ₁₀ H ₁₀ O	2, 4-Dimethylcoumarone.....	22.2	1.0347	1.54260	1.54846	1.56339	1.57683	(41)
C ₁₀ H ₁₀ O	1-Phenyl-3-hydroxy-1-butine.....	12.6	1.0363	1.56694	1.57305	1.58936	1.6034	(150)
C ₁₀ H ₁₀ O	Benzalacetone.....	45.9	1.0091	1.57466	1.58359	1.60999		(8)
C ₁₀ H ₁₀ O	Propenyl phenyl ketone.....	18.3	1.0298	1.55465	1.56091	1.57896	1.59544	(24)
C ₁₀ H ₁₀ O	β-Methylhydrindone.....	21.0	1.0653	1.54812	1.55338	1.56820	1.58139	(16)
C ₁₀ H ₁₀ O	α-Ketotetrahydronaphthalene.....	15.45	1.0989	1.56569	1.57118	1.58655	1.60032	(16)
C ₁₀ H ₁₀ OS	2-Ethoxythionaphthene.....	17.9	1.1591	1.59779	1.60495	1.62362	1.64098	(41)
C ₁₀ H ₁₀ O ₂	Benzoylacetone.....	77.8	1.0560	1.55845	1.56775	1.59597	1.62646	(56)
C ₁₀ H ₁₀ O ₂	Safrole.....	12	1.110	1.5369	1.5420	1.5557	1.5679	(128, † 132)
C ₁₀ H ₁₀ O ₂	Isosafrole.....	12	1.128	1.5693	1.5763	1.5963	1.6155	(128)
C ₁₀ H ₁₀ O ₂	2-Ethoxycoumarone.....	17.9	1.1061	1.54210	1.54773	1.56267	1.57619	(41)
C ₁₀ H ₁₀ O ₂	1-Methyl-6-methoxycoumarone.....	14.25	1.1252	1.55977	1.56616	1.58186	1.58638	(23)
C ₁₀ H ₁₀ O ₂	4-Methyl-2-methoxycoumarone.....	24.3	1.1074	1.54458	1.55036	1.56572	1.57971	(41)
C ₁₀ H ₁₀ O ₂	6-Methylchromanone.....	57.1	1.1246	1.54889	1.55529	1.57285	1.59138	(19)
C ₁₀ H ₁₀ O ₂	Methyl cinnamate.....	21.4	1.0881	1.56831	1.57661	1.59940	1.62155	(45, 107 †)
C ₁₀ H ₁₀ O ₂	Methyl allocinnamate.....	22.9	1.0761	1.54931	1.55616	1.57500	1.59262	(45, 107 †)

Formula	Name	$t, ^\circ\text{C}$	d_4^t	α	D	β	γ	Lit.
$\text{C}_{10}\text{H}_{10}\text{O}_2$	Phenylvinyl acetate.....	22.9	1.0658	1.54255	1.54944	1.56930	1.58344	(43)
$\text{C}_{10}\text{H}_{10}\text{O}_3$	Propiophenone- <i>o</i> -carboxylic acid.....	99.1	1.1402	1.51327	1.51767	1.52944		(49)
$\text{C}_{10}\text{H}_{10}\text{O}_3$	Ethyl benzoylformate.....	25.1	1.1222	1.51373	1.51904		1.54458	(105)
$\text{C}_{10}\text{H}_{10}\text{O}_3$	Ethyl phenylglyoxylate.....	13.35	1.1255	1.51516	1.52008	1.53432	1.54722	(18)
$\text{C}_{10}\text{H}_{10}\text{O}_3$	Methyl benzoylacetate.....	24.7	1.1524	1.53083	1.53654	1.55145	1.56551	(17, † 50)
$\text{C}_{10}\text{H}_{10}\text{O}_4$	Dimethyl phthalate.....	20.8	1.1911	1.51141	1.51546	1.52735	1.53763	(49)
$\text{C}_{10}\text{H}_{10}\text{O}_4$	Monoethyl phthalate.....	22.0	1.1877	1.50490	1.50875	1.52028		(49)
$\text{C}_{10}\text{H}_{11}\text{BrO}$	α -Bromo- <i>n</i> -butyrophenone.....	13.25	1.3724	1.55996	1.56520	1.58035	1.59378	(65)
$\text{C}_{10}\text{H}_{11}\text{BrO}$	α -Bromoisobutyrophenone.....	14.4	1.3613	1.55425	1.55923	1.57369	1.58617	(65)
$\text{C}_{10}\text{H}_{11}\text{ClO}_2$	<i>o</i> -Isobutyro- <i>p</i> -chlorophenol.....	16.4	1.1958	1.54737	1.55379*	1.57182	1.59052	(40)
$\text{C}_{10}\text{H}_{11}\text{Cl}_3$	5-Chloro-1, 3-dimethyl-4(β , β -dichloro-ethyl)-benzene.....	16.1	1.2622	1.54788	1.55278	1.56427	1.57091	(4)
$\text{C}_{10}\text{H}_{11}\text{Cl}_3$	5-Chloro-1, 3-dimethyl-1-dichloro-methyl-4-methene-2, 5-cyclohexadiene.....	17.3	1.2693	1.56255	1.56812	1.58230		(4)
$\text{C}_{10}\text{H}_{11}\text{NO}$	β -Methyl- μ -phenyloxazoline.....	22.9	1.0704	1.54065	1.54598		1.57247	(106)
$\text{C}_{10}\text{H}_{12}$	β -Butenylbenzene.....	21.0	0.9008	1.5269	1.5390	1.5545	1.5834	(132)
$\text{C}_{10}\text{H}_{12}$	α , β -Dimethylstyrene.....	19.7	0.9095	1.52930	1.53496	1.54895	1.56172	(43)
$\text{C}_{10}\text{H}_{12}$	β , β -Dimethylstyrene.....	19.6	0.8986	1.52185	1.52733	1.54105	1.55357	(43)
$\text{C}_{10}\text{H}_{12}$	β -Ethylstyrene.....	19.4	0.9097	1.53401	1.54019	1.55615	1.57083	(78)
$\text{C}_{10}\text{H}_{12}$	<i>p</i> -Methyl- α -methylstyrene.....	18.7	0.9022	1.52870	1.53447	1.54944	1.56306	(8)
$\text{C}_{10}\text{H}_{12}$	1, 2, 3, 4-Tetrahydronaphthalene.....	20.2	0.9729	1.54181	1.54614	1.55869	1.56914	(10, 145)
$\text{C}_{10}\text{H}_{12}\text{Cl}_2\text{O}_2$	<i>d</i> -Dehydrocamphoryl chloride.....	48.0	1.2189	1.50059	1.50433	1.51363	1.52171	(80)
$\text{C}_{10}\text{H}_{12}\text{N}_2$	Ethylethenyl- <i>o</i> -phenylenediamine.....	19.8	1.0726	1.57420	1.58023	1.59622	1.61054	(109)
$\text{C}_{10}\text{H}_{12}\text{N}_2$	1-Ethyl-3-methylindazole.....	16.6	1.0387	1.55806	1.56448*	1.58082	1.59657	(60)
$\text{C}_{10}\text{H}_{12}\text{N}_2$	1-Ethyl-5-methylindazole.....	16.1	1.0462	1.56359	1.56996*	1.58638	1.60180	(60)
$\text{C}_{10}\text{H}_{12}\text{N}_2$	2-Ethyl-3-methylindazole.....	16.6	1.0611	1.58084	1.58818*	1.60726	1.62593	(60)
$\text{C}_{10}\text{H}_{12}\text{N}_2$	2-Ethyl-5-methylindazole.....	15.8	1.0540	1.57535	1.58245*	1.60079	1.61840	(60)
$\text{C}_{10}\text{H}_{12}\text{N}_2$	1-Isopropylindazole.....	17.9	1.0387	1.55563	1.56184*	1.57729	1.59179	(60)
$\text{C}_{10}\text{H}_{12}\text{N}_2$	2-Isopropylindazole.....	15.4	1.0552	1.57515	1.58207*	1.60007	1.61712	(60)
$\text{C}_{10}\text{H}_{12}\text{N}_2$	1-Propylindazole.....	18.7	1.0405	1.55726	1.56350*	1.57919	1.59390	(60)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>asym.</i> -Aceto- <i>o</i> -xylene.....	15.5	1.0073	1.53558	1.54083	1.55578	1.56916	(89)
$\text{C}_{10}\text{H}_{12}\text{O}$	Aceto- <i>p</i> -xylene (2, 4-dimethylacetophenone).....	18.55	0.9962	1.52479	1.53005	1.54349	1.55550	(41)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>o</i> -Allylanisole.....	14.35	0.9775	1.52149	1.52684	1.53919	1.55029	(47)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>o</i> -Allyl- <i>o</i> -cresol.....	15.2	1.0041	1.53580	1.54059	1.55359	1.56485	(47)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>o</i> -Allyl- <i>p</i> -cresol.....	15.75	1.0058	1.53772	1.54245	1.55571	1.56724	(47)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>o</i> -Cresol allyl ether.....	15.4	0.9687	1.51439	1.51876	1.53111	1.54160	(47)
$\text{C}_{10}\text{H}_{12}\text{O}$	1', 5-Dimethyl-2-hydroxystyrene.....	18.2	1.0134	1.54635	1.55216	1.56638	1.57902	(14)
$\text{C}_{10}\text{H}_{12}\text{O}$	α -Ethoxystyrene.....	23.2	0.9673	1.52233	1.52775	1.54198	1.55480	(5)
$\text{C}_{10}\text{H}_{12}\text{O}$	β -Ethoxystyrene.....	21.2	0.9716	1.54346	1.55023	1.56838	1.58530	(5)
$\text{C}_{10}\text{H}_{12}\text{O}$	1'-Methyl-2-methoxystyrene.....	14.85	0.9882	1.53074	1.53575	1.55005	1.56252	(14)
$\text{C}_{10}\text{H}_{12}\text{O}$	1'-Methyl-3-methoxystyrene.....	11.8	0.9985	1.54020	1.54574	1.56124	1.57504	(14)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>o</i> -Propenyl- <i>p</i> -cresol.....	9.0	1.0291	1.57101	1.57768	1.59639	1.61410	(14)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>o</i> -Propenylphenylmethyl ether.....	15	0.9962	1.55318	1.55968	1.57766	1.59423	(14)
$\text{C}_{10}\text{H}_{12}\text{O}$	3, 4-Dimethylacetophenone.....	15.0	1.0085	1.53563	1.54128	1.55603	1.56944	(8)
$\text{C}_{10}\text{H}_{12}\text{O}$	Isopropyl phenyl ketone.....	16.6	0.9865	1.51445	1.51919	1.53172	1.54286	(8 †, 43)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>p</i> -Propiotoluene.....	20.75	0.9899	1.52184	1.52714	1.54072	1.55289	(41)
$\text{C}_{10}\text{H}_{12}\text{O}$	<i>n</i> -Propyl phenyl ketone.....	18.25	0.9899	1.51581	1.52016	1.53298	1.54402	(16)
$\text{C}_{10}\text{H}_{12}\text{O}$	Anethole.....	11.5	0.999	1.5558	1.5624	1.5813	1.5988	(128, 156)
$\text{C}_{10}\text{H}_{12}\text{O}$	1, 4-Dimethyleoumarane.....	13.7	1.0145	1.52331	1.52792	1.54044	1.55162	(16)
$\text{C}_{10}\text{H}_{12}\text{O}$	1, 6-Dimethylcoumarane.....	13.8	1.0148	1.52509	1.52967	1.54211	1.55293	(16)
$\text{C}_{10}\text{H}_{12}\text{O}$	4, 6-Dimethylcoumarane.....	18.9	1.0261	1.53069	1.53579	1.54830	1.55968	(16)
$\text{C}_{10}\text{H}_{12}\text{O}$	Methylchavicol.....	11.5	0.979	1.5199	1.5244	1.5371	1.5476	(128)
$\text{C}_{10}\text{H}_{12}\text{O}$	5-Methylehromane.....	14.3	1.0374	1.53692	1.54205	1.55437	1.56547	(16)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	<i>m</i> -Aceto- <i>p</i> -methoxytoluene (2-methoxy-5-methylacetophenone).....	13.8	1.0693	1.53229	1.53769	1.55336	1.56802	(41)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	<i>o</i> -Allylguaiacol.....	12.75	1.0724	1.53778	1.54259	1.55592	1.56734	(47)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	Chavibetol.....	16	1.065	1.5349	1.5397	1.5527	1.5644	(128)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	Guaiacyl allyl ether.....	12.75	1.0604	1.53203	1.53671	1.54987	1.56122	(47)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	Eugenol.....	14.5	1.072	1.5385	1.5439	1.5574	1.5692	(128)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	Isoeugenol.....	18	1.09	1.5617	1.5680	1.5868		(128)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	<i>o</i> -Propio- <i>p</i> -cresol.....	13.8	1.0843	1.54211	1.54852	1.56760	1.58693	(41)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	Ethyl phenylacetate.....	18.5	1.0348	1.49530	1.49921		1.51718	(105)
$\text{C}_{10}\text{H}_{12}\text{O}_2$	Ethyl <i>o</i> -toluate.....	21.6	1.0324	1.50229	1.50699	1.51849	1.52884	(41)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ²⁵	α	D	β	γ	Lit.
C ₁₀ H ₁₂ O ₂	Ethyl <i>m</i> -toluate.....	21.6	1.0261	1.50042	1.50502	1.51670	1.52718	(41)
C ₁₀ H ₁₂ O ₂	Ethyl <i>p</i> -toluate.....	18.2	1.0269	1.50418	1.50888	1.52106	1.53183	(8)
C ₁₀ H ₁₂ O ₂	Ethyl <i>o</i> -methoxybenzoate.....	14.55	1.1156	1.51913	1.52379	1.53694	1.54856	(41)
C ₁₀ H ₁₂ O ₃	Ethyl <i>m</i> -methoxybenzoate.....	16.4	1.1032	1.51195	1.51697	1.52955	1.54111	(41)
C ₁₀ H ₁₂ O ₃	Ethyl <i>p</i> -methoxybenzoate.....	14.3	1.1091	1.52183	1.52739	1.54143	1.55436	(41)
C ₁₀ H ₁₃ Cl ₃ O ₂	<i>d</i> -Chlorocamphoryl chloride.....	31.3	1.3221	1.50497	1.50797	1.51512	1.52133	(80)
C ₁₀ H ₁₃ N	γ -Methyltetrahydroquinoline.....	23.1	1.0191	1.57354	1.58015	1.59789	1.61213	(109)
C ₁₀ H ₁₃ N	<i>N</i> -Methyltetrahydroquinoline.....	17.3	1.0236	1.57620	1.58268	1.60057		(25)
C ₁₀ H ₁₃ N	<i>ar.</i> -Tetrahydro- α -naphthylamine.....	23.1	1.0542	1.58385	1.58964		1.61805	(106)
C ₁₀ H ₁₃ N	<i>ac.</i> -Tetrahydro- β -naphthylamine.....	22.2	1.0295	1.55570	1.56039		1.58354	(106)
C ₁₀ H ₁₄	Cymene.....	23.8	0.8527	1.47925	1.48303	1.49222	1.50017	(98,† 134, 145, 148, 162)
C ₁₀ H ₁₄	<i>p</i> -Diethylbenzene.....	16.2	0.8679	1.49499	1.49897	1.50993	1.51924	(20)
C ₁₀ H ₁₄	1, 1-Dimethyl-4-ethene-2, 5-cyclohexadiene.....	15.15	0.8614	1.51072	1.51572	1.53015	1.54300	(89)
C ₁₀ H ₁₄	<i>asym.</i> -Ethyl- <i>o</i> -xylene.....	15.05	0.8776	1.50103	1.50489	1.51606	1.52531	(89)
C ₁₀ H ₁₄	Hexahydronaphthalene.....	18.4	0.9581	1.52879	1.53311	1.54397	1.55340	(155, 156)
C ₁₀ H ₁₄	Isobutylbenzene.....	14.5	0.87163	1.4916	1.4957	1.5056	1.5141	(148)
C ₁₀ H ₁₄	<i>o</i> -Methylisopropylbenzene.....	16.15	0.8789	1.49826	1.50206	1.51290	1.52185	(20)
C ₁₀ H ₁₄	<i>m</i> -Methylisopropylbenzene.....	17.05	0.8628	1.49016	1.49385	1.50452	1.51336	(20)
C ₁₀ H ₁₄	<i>p</i> -Methylisopropylbenzene.....	15.0	0.8631	1.49105	1.49474	1.50537	1.51449	(20)
C ₁₀ H ₁₄	<i>o</i> -Methylpropylbenzene.....	15.75	0.8770	1.49765	1.50139	1.51218	1.52125	(20)
C ₁₀ H ₁₄	<i>m</i> -Methylpropylbenzene.....	17.0	0.8648	1.49262	1.49640	1.50738	1.51646	(20,† 61)
C ₁₀ H ₁₄	<i>p</i> -Methylpropylbenzene.....	18.8	0.8620	1.49278	1.49655	1.50765	1.51687	(20, 61†)
C ₁₀ H ₁₄	1, 2, 3, 4-Tetramethylbenzene.....	16.0	0.9044	1.51621	1.52031	1.53192	1.54189	(20)
C ₁₀ H ₁₄	1, 1, 2-Trimethyl-4-methene-2, 5-cyclohexadiene.....	10.7	0.8735	1.51331	1.51813	1.53213	1.54435	(89)
C ₁₀ H ₁₄ Cl ₂ O	1-Ethyl-4-methyl-4-dichloromethyl-1-cyclohexen-3-one.....	17	1.1953	1.51908	1.52331	1.53285	1.54166	(52)
C ₁₀ H ₁₄ Cl ₂ O	1-Ethyl-4-methyl-4-dichloromethyl-5-cyclohexen-3-one.....	17.4	1.1671	1.49967	1.50292	1.51067	1.51723	(52)
C ₁₀ H ₁₄ Cl ₂ O	1, 4, 5-Trimethyl-1-dichloromethyl-3-cyclohexen-2-one.....	19.8	1.1971	1.52013	1.52392	1.53417	1.54298	(88)
C ₁₀ H ₁₄ Cl ₂ O ₂	<i>d-cis</i> -Camphoryl chloride.....	19.9	1.2449	1.49846	1.50133	1.50842	1.51443	(80)
C ₁₀ H ₁₄ Cl ₂ O ₂	<i>l-trans</i> -Camphoryl chloride.....	20.7	1.2269	1.49593	1.49880	1.50606	1.51206	(80)
C ₁₀ H ₁₄ N ₂	Nicotine.....	22.4	1.0121	1.51980	1.52392		1.54387	(106)
C ₁₀ H ₁₄ N ₂	Metan nicotine.....	19.7	1.0017	1.54906	1.55509	1.57059	1.58475	(106)
C ₁₀ H ₁₄ N ₂ O	2-Acetyl-5-methyltetrahydroindazole...	17.9	1.0807	1.51796	1.52228*	1.53290	1.54247	(60)
C ₁₀ H ₁₄ N ₂ O ₂	Ethyl 1-allyl-3-methylpyrazole-5-carboxylate.....	16.0	1.0495	1.48654	1.49081*	1.50116	1.51096	(38)
C ₁₀ H ₁₄ N ₂ O ₂	Ethyl 1-allyl-5-methylpyrazole-3-carboxylate.....	15.9	1.0803	1.49947	1.50362*	1.51376	1.52350	(38)
C ₁₀ H ₁₄ O	<i>p</i> -Tolyldimethyl carbinol.....	13.5	0.9844	1.51831	1.52215	1.53353	1.54298	(145)
C ₁₀ H ₁₄ O	<i>asym.</i> -Ethoxy- <i>m</i> -xylene.....	13.95	0.9487	1.50297	1.50692	1.51874	1.52872	(16)
C ₁₀ H ₁₄ O	<i>vic.</i> -Ethoxy- <i>m</i> -xylene.....	13.9	0.9420	1.49337	1.49694	1.50780	1.51666	(16)
C ₁₀ H ₁₄ O	Hemimellitenyl methyl ether.....	22.9	0.9739	1.51846	1.52272	1.53470	1.54520	(47)
C ₁₀ H ₁₄ O	Mesityl methyl ether.....	14.4	0.9531	1.50161	1.50553	1.51672	1.52615	(16, 47†)
C ₁₀ H ₁₄ O	Pseudocumenyl methyl ether.....	13.9	0.9690	1.51777	1.52203	1.53433	1.54455	(47)
C ₁₀ H ₁₄ O	<i>asym.</i> - <i>o</i> -Xylenyl ethyl ether.....	14.95	0.9545	1.50770	1.51194	1.52363	1.53330	(47)
C ₁₀ H ₁₄ O	<i>vic.</i> - <i>o</i> -Xylenyl ethyl ether.....	15.9	0.9559	1.50790	1.51187	1.52361	1.53342	(47)
C ₁₀ H ₁₄ O	<i>asym.</i> - <i>m</i> -Xylenyl ethyl ether.....	13.95	0.9487	1.50297	1.50692	1.51874	1.52872	(16,† 47)
C ₁₀ H ₁₄ O	<i>sym.</i> - <i>m</i> -Xylenyl ethyl ether.....	15.2	0.9437	1.50305	1.50705	1.51862	1.52814	(47)
C ₁₀ H ₁₄ O	<i>vic.</i> - <i>m</i> -Xylenyl ethyl ether.....	13.9	0.9420	1.49337	1.49694	1.50780	1.51666	(16,† 47)
C ₁₀ H ₁₄ O	<i>p</i> -Xylenyl ethyl ether.....	12.65	0.9451	1.50288	1.50699	1.51867	1.52827	(47)
C ₁₀ H ₁₄ O	Carvacrol.....	18.6	0.9774	1.52009	1.52450	1.53581	1.54550	(47, 110†)
C ₁₀ H ₁₄ O	Thymol.....	24.4	0.9689	1.51453	1.51893	1.53012	1.53998	(156, 161)
C ₁₀ H ₁₄ O	Carvone.....	18.7	0.9611	1.49554	1.49935	1.50908	1.51780	(43)
C ₁₀ H ₁₄ O	<i>d</i> -Carvone.....	18.2	0.9626	1.49614	1.49994	1.50978	1.51824	(110)
C ₁₀ H ₁₄ O	Eucarvone.....	21.2	0.9840	1.50339	1.50872	1.52341	1.53794	(16)
C ₁₀ H ₁₄ O ₂	1-Methyl-4-ethyl-1, 3-cyclohexadiene-3-carboxylic acid.....	14.8	1.0284	1.49496	1.49887	1.50831	1.51684	(54)
C ₁₀ H ₁₄ O ₂	Methyl 1, 4-dimethyl-1, 3-cyclohexadiene-2-carboxylate.....	16.8	0.9976	1.47338	1.47681	1.48544	1.49300	(45)

Formula	Name	t_i , °C	d_4^t	α	D	β	γ	Lit.
C ₁₀ H ₁₄ O ₂	Methyl 3, 6-dimethyl-2, 6-cyclohexadienecarboxylate.....	18	0.9965	1.47358	1.47643	1.48458	1.49173	(51)
C ₁₀ H ₁₄ O ₄	Diethyl muconate.....	99.1	0.9829	1.46178	1.46755*	1.48259	1.49695	(27)
C ₁₀ H ₁₅ N	Diethylaniline.....	22.3	0.9325	1.53509	1.54105		1.57077	(106, † 145)
C ₁₀ H ₁₅ NO	1-Propyl-1-cyano cyclohexan-2-one.....	20.1	0.9968	1.46459	1.46721*	1.47320	1.47836	(39)
C ₁₀ H ₁₅ NO ₂	Ethyl α -cyano- Δ^1 -isoheptenate.....	19.7	0.9666	1.45198	1.45502	1.46340	1.47037	(58)
C ₁₀ H ₁₅ NO ₃	Amyl α -acetocyanacetate.....	20	1.0328	1.4639	1.4676	1.4772	1.4857	(138)
C ₁₀ H ₁₅ NO ₄	Diethyl ethylcyanomalonate.....	20	1.0521	1.4245	1.4267	1.4319	1.4363	(138)
C ₁₀ H ₁₆	2, 6-Dimethyl-3, 5, 7-octatriene.....	15.6	0.8119	1.54403	1.54558	1.57682	1.60086	(45)
C ₁₀ H ₁₆	<i>d</i> -Limonene.....	14.7	0.8468	1.47172	1.47489	1.48277	1.49062	(78, † 120, 125)
C ₁₀ H ₁₆	<i>l</i> -Limonene.....	20.5	0.8407	1.47157	1.47468	1.48256	1.48924	(120)
C ₁₀ H ₁₆	1-Methyl-4-isopropyl-1, 3-cyclohexadiene.....	19.4	0.8361	1.47359	1.47810	1.48837	1.49795	(52)
C ₁₀ H ₁₆	Myrcene.....	15.8	0.8082	1.46684		1.48061	1.48923	(43)
C ₁₀ H ₁₆	<i>d</i> - α -Pinene.....	18.05	0.8594	1.46354	1.46634	1.47322	1.47925	(78)
C ₁₀ H ₁₆	<i>l</i> - α -Pinene.....	16.25	0.8621	1.46517	1.46803	1.47509	1.48098	(78)
C ₁₀ H ₁₆	<i>l</i> -Pinene.....	23.5	0.8570	1.46252	1.46526	1.47202	1.47779	(98)
C ₁₀ H ₁₆	Sabinene.....	17.0	0.8422	1.46428	1.46738	1.47514	1.48196	(78)
C ₁₀ H ₁₆	Sylvestrene.....	17.2	0.8486	1.47380	1.47717	1.48505	1.49245	(78, † 125)
C ₁₀ H ₁₆ Cl ₂ O ₂	Sebaeyl chloride.....	18.3		1.46570	1.46836	1.47503		(80)
C ₁₀ H ₁₆ N ₂	1-Ethyl-5-methyltetrahydroindazole....	21.4	0.9837	1.49761	1.50103*	1.50940	1.51637	(60)
C ₁₀ H ₁₆ N ₂	2-Ethyl-5-methyltetrahydroindazole....	19.8	0.9866	1.49678	1.50009*	1.50818	1.51513	(60)
C ₁₀ H ₁₆ N ₂	2-Ethyl-7-methyltetrahydroindazole....	14.4	0.9954	1.50660	1.51011*	1.51854	1.52566	(60)
C ₁₀ H ₁₆ O	<i>d</i> -Carone.....	18.8	0.9577	1.47597	1.47877	1.48560	1.49122	(110)
C ₁₀ H ₁₆ O	Carvenone.....	16.7	0.9300	1.48028	1.48463	1.49304	1.50134	(43, † 44, 110)
C ₁₀ H ₁₆ O	Carvotanacetone.....	20	0.9351	1.47730	1.48056	1.48887	1.49606	(43, † 110)
C ₁₀ H ₁₆ O	Dihydrocarvone.....	17.5	0.9273	1.46884	1.47175	1.47870	1.48449	(110)
C ₁₀ H ₁₆ O	Dihydroeucarvone.....	18.9	0.9232	1.46455	1.46737	1.47406	1.47965	(110)
C ₁₀ H ₁₆ O	Fenchone.....	14.5	0.9488	1.46232		1.47076	1.47571	(130)
C ₁₀ H ₁₆ O	Pulegone.....	18.3	0.9371	1.48328	1.48705	1.49623	1.50437	(43)
C ₁₀ H ₁₆ O	Tanacetone.....	17.6	0.9182	1.44986	1.45220	1.45808	1.46279	(110)
C ₁₀ H ₁₆ O	1, 1, 2, 4-Tetramethyl-2, 5-cyclohexadien-4-ol.....	10.1	0.9332	1.48376	1.48685	1.49502	1.50176	(89)
C ₁₀ H ₁₆ O ₂	1, 3-Dimethyl-4-cyclohexene-5-acetic acid.....	20.3	0.9945	1.47428	1.47731	1.48449	1.49068	(76, 84)
C ₁₀ H ₁₆ O ₂	Geranic acid.....	20.2	0.9518	1.48284	1.48695	1.49758	1.50690	(44)
C ₁₀ H ₁₆ O ₂	Ethyl cyclohexene-1-acetate.....	16.2	0.9892	1.46422	1.46906	1.47414	1.48017	(46)
C ₁₀ H ₁₆ O ₂	Ethyl cyclohexylideneacetate.....	16.9	0.9825	1.47721	1.48083	1.48963	1.49737	(46)
C ₁₀ H ₁₆ O ₂	Ethyl diallylacetate.....	19.1	0.8976	1.43354	1.43638	1.44312	1.44888	(71)
C ₁₀ H ₁₆ O ₂	Methyl 3-methylcyclohexeneacetate....	15.7	0.9692	1.45524	1.45822		1.47071	(46)
C ₁₀ H ₁₆ O ₂	Methyl 4-methylcyclohexeneacetate....	16.9	0.9614	1.45132	1.45402	1.46149	1.46648	(46)
C ₁₀ H ₁₆ O ₂	Methyl 2-methylcyclohexylideneacetate.	14.2	0.9767	1.47681	1.48072	1.48991	1.49802	(46)
C ₁₀ H ₁₆ O ₂	Methyl 3-methylcyclohexylideneacetate.	15.5	0.9752	1.47534	1.47926	1.48845	1.49668	(46)
C ₁₀ H ₁₆ O ₂	Methyl 4-methylcyclohexylideneacetate.	16.9	0.9702	1.47200	1.47583	1.48506	1.49329	(46)
C ₁₀ H ₁₆ O ₂	Methyl isolauronolate.....	17.3	0.97207	1.46634	1.46970	1.47795	1.48517	(43)
C ₁₀ H ₁₆ O ₂	Methyl 1,4-dimethyl-3-cyclohexene-3-carboxylate.....	19	0.9708	1.45656	1.45922	1.46585	1.47142	(54)
C ₁₀ H ₁₆ O ₂	Ethyl amylpropiolate.....	11.5	0.9207	1.44842	1.45142	1.4583	1.4644	(150)
C ₁₀ H ₁₆ O ₂	Methyl hexylpropiolate.....	12.5	0.9238	1.44915	1.45182	1.4588	1.4647	(150)
C ₁₀ H ₁₆ O ₂	Methyl α -cyclohexenepropionate.....	18.3	0.9864	1.46373	1.46648	1.47321	1.47885	(46)
C ₁₀ H ₁₆ O ₂	Ethyl β , δ -dimethylsorbate.....	18.5	0.9343	1.48301	1.48823*	1.50175	1.51447	(27)
C ₁₀ H ₁₆ O ₂	Ethyl α -ethylsorbate.....	15.3	0.9345	1.49076	1.49653	1.51162	1.52605	(27)
C ₁₀ H ₁₆ O ₂	Ethyl Δ^1 -tetrahydro- <i>m</i> -toluate.....	18.45	0.9758	1.46413	1.46748*	1.47473	1.48126	(26)
C ₁₀ H ₁₆ O ₄	Diethyl <i>cis</i> - β -methylglutaeonate.....	21.2	1.0332	1.44858	1.45161*	1.45918	1.46562	(73)
C ₁₀ H ₁₆ O ₄	Diethyl <i>trans</i> - β -methylglutaeonate.....	21.2	1.0330	1.44828	1.45147*	1.45883	1.46538	(73)
C ₁₀ H ₁₆ O ₄	Diethyl isopropylidenemalonate.....	17.0	1.0284	1.44562	1.44857	1.45602	1.46233	(45)
C ₁₀ H ₁₆ O ₄	Dipropyl fumarate.....	20	1.0220	1.44133	1.44347	1.45148	1.45771	(45, † 144)
C ₁₀ H ₁₆ O ₄	Dipropyl maleate.....	20	1.0290	1.44092	1.44372	1.45053	1.45630	(45, † 144)
C ₁₀ H ₁₆ O ₆	Diethyl ethoxymethylenemalonate.....	15.3	1.0811	1.45966	1.46307	1.47235	1.48060	(17)
C ₁₀ H ₁₆ O ₆	Diethyl propionylmalonate.....	16.4	1.0791	1.44102	1.44358	1.45095	1.45701	(34, † 56)
C ₁₀ H ₁₆ O ₆	Ethyl α -methyl- β -hydroxycarbethoxy- α , β -erotate.....	17.6	1.0799	1.43829	1.44091		1.45308	(43, 105 †)
C ₁₀ H ₁₆ O ₆	Triethyl methanetricarboxylate.....	16.15	1.1084	1.42558	1.42748	1.43313	1.43762	(35)
C ₁₀ H ₁₇ N	1-Cyano-2-methyl-5-isopropylcyclopentane.....	16.2	0.8814	1.44751		1.45538	1.45994	(130)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ^t	<i>α</i>	D	<i>β</i>	<i>γ</i>	Lit.
C ₁₀ H ₁₇ NO	α-Fencholamide.....	117.9	0.9331	1.46216		1.47226	1.47833	(130)
C ₁₀ H ₁₇ NO ₂	Acetyl tropein.....	15.4	1.0627	1.47456	1.47687	1.48321		(25)
C ₁₀ H ₁₇ NO ₃	Methyl <i>l</i> -ecgoninate.....	20.5	1.1468	1.48474	1.48765			(25)
C ₁₀ H ₁₈	Decahydronaphthalene.....	18.0	0.8952	1.47789	1.48035	1.48638	1.49154	(10)
C ₁₀ H ₁₈	Menthene.....	20.4	0.8060	1.44562	1.44813	1.45484	1.46026	(98)
C ₁₀ H ₁₈	1, 2, 4, 5-Tetramethyl-4-cyclohexene....	16.5	0.8199	1.45617	1.45880	1.46597	1.47192	(21)
C ₁₀ H ₁₈ O	Diallylpropyl carbinol.....	21.1	0.8645	1.45394	1.45677	1.46378	1.46945	(141)
C ₁₀ H ₁₈ O	Diisovaleric aldehyde.....	17.4	0.8542	1.44327		1.45463	1.46162	(43)
C ₁₀ H ₁₈ O	Δ ^{4,8} -Menthen-1-ol.....	80	0.8948	1.46277		1.47297	1.47904	(130)
C ₁₀ H ₁₈ O	Δ ^{8,9} -Menthen-1-ol.....	79.8	0.8703	1.44612		1.45526	1.46059	(130)
C ₁₀ H ₁₈ O	1, 1, 4, 4-Tetramethylcyclohexan-2-one.	14.3	0.8931	1.44635	1.44849	1.45452	1.45957	(68)
C ₁₀ H ₁₈ O ₂	1, 3-Dimethylcyclohexanyl 5-acetate....	20.2	0.9277	1.43526	1.43758	1.44312	1.44771	(55)
C ₁₀ H ₁₈ O ₃	Ethyl diethylacetoacetate.....	17.2	0.9707	1.43031	1.43266	1.43806	1.44269	(6, † 9, 105)
C ₁₀ H ₁₈ O ₃	Methyl β-amyl-β-methoxyacrylate.....	23.1	0.9610	1.45157	1.45494	1.46328	1.47076	(17)
C ₁₀ H ₁₈ O ₄	Diethyl <i>asym.</i> -dimethylsuccinate.....	14.0	0.9988	1.42194	1.42406*	1.42925	1.43343	(73)
C ₁₀ H ₁₈ O ₄	Diethyl <i>fum.-sym.</i> -dimethylsuccinate....	14.9	1.000	1.42157	1.42377*	1.42887	1.43312	(73)
C ₁₀ H ₁₈ O ₄	Diethyl <i>mal.-sym.</i> -dimethylsuccinate....	14.3	1.0015	1.42355	1.42568*	1.43084	1.43515	(73)
C ₁₀ H ₁₈ O ₄	Diethyl methylethylmalonate.....	18.2	0.9970	1.41696	1.41896	1.42417	1.42837	(9)
C ₁₀ H ₁₉ Cl	1, 2, 4, 5-Tetramethylcyclohexyl 4-chloride.....	13.95	0.9406	1.46288	1.46515	1.47150	1.47655	(21)
C ₁₀ H ₁₉ N	Camphylamine.....	17.8	0.8736	1.46992	1.47284		1.48555	(106)
C ₁₀ H ₁₉ NO	1-Methyl-3-isopropylcyclopentane-1-carboxamide.....	108.2	0.9072	1.44683		1.45543	1.46042	(130)
C ₁₀ H ₂₀	Decene.....	17	0.7721	1.4357	1.4385	1.4447	1.4500	(148, † 155, 156)
C ₁₀ H ₂₀	1, 2, 4, 5-Tetramethylcyclohexane.....	13.1	0.7910	1.43517	1.43718	1.44307	1.44772	(21)
C ₁₀ H ₂₀ O	2, 6-Dimethyl-2-octen-6-ol.....	15.9	0.8576	1.45275	1.45552	1.46216	1.46737	(71)
C ₁₀ H ₂₀ O	Allyldipropyl carbinol.....	19.0	0.8446	1.44201	1.44452	1.45070	1.45575	(141)
C ₁₀ H ₂₀ O	1, 1, 4, 4-Tetramethylcyclohexan-2-ol..	30.2	0.8935	1.45471	1.45714	1.46295	1.46777	(68)
C ₁₀ H ₂₀ O	1, 2, 4, 5-Tetramethylcyclohexan-4-ol..	18.1	0.8983	1.45738	1.45945	1.46543	1.47021	(21)
C ₁₀ H ₂₀ O ₂	Isoamyl isovalerate.....	19.0	0.85840	1.41095	1.41311	1.41814	1.42335	(125)
C ₁₀ H ₂₁ Br	<i>n</i> -Decyl bromide.....	20	1.0683	1.45251	1.45504	1.46116	1.46636	(163)
C ₁₀ H ₂₁ Cl	<i>n</i> -Decyl chloride.....	20	0.8696	1.43573	1.43799	1.44346	1.44794	(163)
C ₁₀ H ₂₁ I	<i>n</i> -Decyl iodide.....	20	1.2564	1.48269	1.48589	1.49377	1.50051	(163)
C ₁₀ H ₂₁ N	Isoamyl isoamylideneamine.....	18.9	0.7724	1.42325	1.42576	1.43177	1.43676	(109)
C ₁₀ H ₂₂	Decane.....	14.9	0.7278	1.4088	1.4108	1.4160	1.4200	(148)
C ₁₀ H ₂₂	Diisoamyl.....	23.2	0.7214	1.40502	1.40702	1.41215	1.41651	(131)
C ₁₀ H ₂₂ O	<i>n</i> -Decyl alcohol.....	20	0.8300	1.43503	1.43719	1.44247	1.44688	(163)
C ₁₀ H ₂₂ S	Isoamyl sulfide.....	20	0.84314	1.44966	1.45238	1.45889	1.46447	(153, 154)
C ₁₀ H ₂₃ N	Diisoamylamine.....	21.1	0.7672	1.42059	1.42289		1.43317	(106)
C ₁₁ H ₈ O	α-Naphthaldehyde.....	19.3	1.1490	1.64404	1.65464	1.68490	1.71624	(145)
C ₁₁ H ₁₀	1-Methylnaphthalene.....	99.2	0.9656	1.57353	1.58077	1.60159	1.62067	(48)
C ₁₁ H ₁₀	2-Methylnaphthalene.....	39.9	0.9939	1.59499	1.60263	1.62395	1.64284	(48)
C ₁₁ H ₁₀ O	Methyl-α-naphthol.....	13.9	1.0964	1.61474	1.62322	1.64597	1.66763	(155, 156)
C ₁₁ H ₁₀ O ₂	δ-Phenyl-Δ ¹ -angelolactone.....	14.9	1.1537	1.56004	1.56580*	1.58011	1.59295	(28)
C ₁₁ H ₁₀ O ₂	δ-Phenyl-Δ ² -angelolactone.....	15.7	1.1173	1.52622	1.53055*	1.54129		(28)
C ₁₁ H ₁₀ O ₂	Ethyl phenylpropiolate.....	13	1.0632	1.5500	1.5566	1.5738	1.5897	(150)
C ₁₁ H ₁₀ O ₂ S	Ethyl thionaphthene-2-carboxylate....	55.4	1.1720	1.58370	1.59178*	1.61332	1.63375	(59)
C ₁₁ H ₁₀ O ₃	Ethyl coumarilate.....	32.2	1.1618	1.55453	1.56194	1.58119	1.60020	(41)
C ₁₁ H ₁₁ ClN ₂	1-Benzyl-3-methyl-4-chloropyrazole....	14.2	1.1621	1.55323	1.55818*	1.57043		(38)
C ₁₁ H ₁₁ ClN ₂	1-Benzyl-5-methyl-4-chloropyrazole....	14.2	1.1847	1.55752	1.56254	1.57476	1.58531	(38)
C ₁₁ H ₁₁ ClO ₂	Ethyl <i>o</i> -chlorocinnamate.....	21.1	1.1683	1.55782	1.56447	1.58439	1.60310	(47)
C ₁₁ H ₁₂	1-Phenyl-1, 3-pentadiene.....	13	0.9384	1.60167	1.61114	1.64065	1.67038	(45, † 142)
C ₁₁ H ₁₂ N ₂	1-Allyl-5-methylindazole.....	12.2	1.0549	1.57276	1.57932*	1.59620	1.61199	(60)
C ₁₁ H ₁₂ N ₂	2-Allyl-5-methylindazole.....	16.6	1.0528	1.58373	1.59100	1.60987	1.62824	(60)
C ₁₁ H ₁₂ N ₂	1-Benzyl-3-methylpyrazole.....	14.2	1.0541	1.55147	1.55643*	1.56872	1.57938	(60)
C ₁₁ H ₁₂ N ₂	1-Phenyl-2, 4-dimethylpyrazole.....	19.3	1.0573	1.56801	1.57384	1.58961	1.60360	(106)
C ₁₁ H ₁₂ N ₂	1-Phenyl-3, 4-dimethylpyrazole.....	19.8	1.0606	1.58023	1.58739*	1.60613	1.62376	(60)
C ₁₁ H ₁₂ N ₂	1-Phenyl-3, 5-dimethylpyrazole.....	16.6	1.0586	1.56897	1.57503*	1.59047	1.60435	(60)
C ₁₁ H ₁₂ N ₂	1-Phenyl-4, 5-dimethylpyrazole.....	18.1	1.0665	1.56933	1.57539*	1.59066	1.60437	(60)
C ₁₁ H ₁₂ N ₂ O	2- <i>n</i> -Butyrylindazole (stable).....	33.5	1.1090	1.55242	1.55854	1.57460	1.58971	(33)
C ₁₁ H ₁₂ N ₂ O	2-Isobutyrylindazole (stable).....	12.8	1.1136	1.55902	1.56534*	1.58140	1.59652	(33)
C ₁₁ H ₁₂ O	α-Benzalmethyl ethyl ketone.....	50.3	0.9875	1.55991	1.56838	1.59237		(8)
C ₁₁ H ₁₂ O	γ-Benzalmethyl ethyl ketone.....	45.3	1.0018	1.56143	1.56907	1.59084		(8)

Formula	Name	$t, ^\circ\text{C}$	d_4^t	α	D	β	γ	Lit.
$\text{C}_{11}\text{H}_{12}\text{O}$	1-Keto-7-methyl-1, 2, 3, 4-tetrahydro-naphthalene.....	35.0	1.0569	1.55168	1.55674	1.57160	1.58479	(145, † 146)
$\text{C}_{11}\text{H}_{12}\text{O}$	ac.-2-M e t h y l-1-1-ketotetrahydronaphthalene.....	20.9	1.0600	1.54669	1.55154	1.56542	1.57764	(146)
$\text{C}_{11}\text{H}_{12}\text{O}$	2, 2-Dimethyl- α -chromene.....	14.4	1.0183	1.54744	1.55372	1.57018	1.58565	(23)
$\text{C}_{11}\text{H}_{12}\text{O}$	4, 6-Dimethyl- α -chromene.....	19.9	1.0420	1.55610	1.56231	1.57851	1.59374	(23)
$\text{C}_{11}\text{H}_{12}\text{O}$	β , β -Dimethyl- α -hydrindone.....	13.9	1.0313	1.53587	1.54078	1.55470	1.56714	(16)
$\text{C}_{11}\text{H}_{12}\text{O}$	3, 3-Dimethyl-1-hydrindone.....	14.25	1.0320	1.54026	1.54525	1.55936	1.57182	(24)
$\text{C}_{11}\text{H}_{12}\text{O}$	1-Phenyl-3-hydroxy-1-pentine.....	13	1.0138	1.55764	1.56333	1.57861	1.59206	(150)
$\text{C}_{11}\text{H}_{12}\text{O}$	1, 2, 4-Trimethylcoumarone.....	14	1.0267	1.54685	1.55332	1.56865	1.58330	(23)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	<i>p</i> -Crotonylanisole.....	11.7	1.0906	1.57861	1.58723*	1.61003	1.63306	(30)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	α -Methyl- β -acetoxystyrene.....	15.2	1.0574	1.53680	1.54278	1.55801	1.57204	(14)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	1'-Methyl-2-acetoxystyrene.....	13.5	1.0481	1.51327	1.51754	1.52983	1.54030	(14)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	1'-Methyl-3-acetoxystyrene.....	14.1	1.0612	1.52765	1.53252	1.54651	1.55872	(14)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	4-Methyl-2-ethoxycoumarone.....	16.6	1.0826	1.53846	1.54395	1.55856	1.57184	(41)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	1, 4-Dimethyl-2-methoxycoumarone....	19.0	1.0806	1.53828	1.54403	1.56052	1.57635	(72)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Methyl- <i>o</i> -coumarketone methyl ether...	61.4	1.0534	1.57525	1.58591	1.61640		(14)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Benzoylacetone <i>O</i> -methyl ether.....	16	1.0679	1.55296	1.55981	1.57810	1.59624	(17)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	2, 5-Dimethyl-7-hydroxyhydrindone....	13.6	1.1293	1.56311	1.56966*	1.58663	1.60329	(30)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	2-Methyl-6-methoxyhydrindone.....	16.9	1.1188	1.55310	1.55884	1.57529		(37)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	1, 1, 4-Trimethylcoumaranone.....	19.3	1.0730	1.53433	1.54040	1.55877	1.57776	(11, 19) †
$\text{C}_{11}\text{H}_{12}\text{O}_2$	1, 3, 5-Trimethylcoumaranone.....	19.2	1.0987	1.55106	1.55739	1.57622	1.59485	(19)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	2, 2, 7-Trimethylcoumaranone.....	100.6	1.0010	1.50063	1.50668*	1.52279	1.54003	(40)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Propionylacetophenone.....	20.0	1.0774	1.57455	1.58400	1.61197	1.64247	(56)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Methylbenzoylacetone.....	20	1.0798	1.53275	1.53834	1.55336	1.56744	(17, † 56)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Ethyl atropate.....	16.1	1.0508	1.52151	1.52605	1.53871	1.54996	(45)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Ethyl allocinnamate.....	22.05	1.0465	1.53769	1.54416	1.56140	1.57743	(45, 79, 107 †)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	<i>trans</i> -Ethyl cinnamate.....	20	1.0490	1.55216	1.55982	1.58043	1.60053	(14, 45, 95, 107 †)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Methyl β -methylcinnamate.....	37.8	1.0544	1.54435	1.55045	1.56883	1.58592	(14)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Methyl allo- β -methylcinnamate.....	38.1	1.0373	1.52274	1.52755	1.54200	1.55457	(14)
$\text{C}_{11}\text{H}_{12}\text{O}_2$	Methyl <i>p</i> -methylcinnamate.....	56.6	1.0273	1.54983	1.55807	1.58130(?)		(14)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	Ethyl hydrocoumarilate.....	13.9	1.1542	1.52103	1.52502	1.53617	1.54577	(16)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	1, 4-Dimethyl-1-methoxycoumaranone..	22.6	1.1299	1.53188	1.53827	1.55672	1.57577	(12)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	1-Methyl-4-methoxycoumarone methyl ether.....	17.4	1.1470	1.54711	1.55313	1.57057	1.58791	(72)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	Methyl <i>p</i> -cresyl diketone methyl ether..	16.0	1.1193	1.53188	1.53780	1.55554		(18)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	α -Ethyl- α -methoxyphthalide.....	20.35	1.1323	1.51533	1.51986	1.53104	1.54104	(49)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	α -Acetoxypropiophenone.....	19.7	1.1126	1.51120	1.51533	1.52729		(15)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	Ethyl benzoylacetate.....	16	1.1185	1.52560	1.53115	1.54587	1.55980	(17, † 56)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	Methyl <i>o</i> -methoxycinnamate.....	16.7	1.1368	1.57609	1.58535	1.61182	1.64016	(14)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	Methyl β -methoxycinnamate.....	24.7	1.1179	1.54337	1.54971	1.56637	1.58186	(14)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	Methyl propiophenone- <i>o</i> -carboxylate....	15.2	1.1288	1.51936	1.52396	1.53577	1.54594	(49)
$\text{C}_{11}\text{H}_{12}\text{O}_3$	Methyl β -phenylmethylglycidate.....	19.9	1.1230	1.50913	1.51319	1.52342	1.53246	(16)
$\text{C}_{11}\text{H}_{13}\text{BrO}_2$	<i>o</i> -(α -Bromoisobutyro)- <i>p</i> -cresol.....	22.3	1.3669	1.56400	1.57141	1.59245	1.61218	(11)
$\text{C}_{11}\text{H}_{13}\text{Cl}$	4-Methyl- α -ethyl- β -chlorostyrene.....	19.85	1.0362	1.53639	1.54177	1.55548	1.56777	(13)
$\text{C}_{11}\text{H}_{14}$	<i>ar</i> -2-Methyltetrahydronaphthalene....	15.1	0.9541	1.53316	1.53719	1.54907	1.55897	(146)
$\text{C}_{11}\text{H}_{14}$	1-Phenyl-2-pentene.....	16.2	0.8884	1.50444	1.50890	1.51986	1.52958	(78)
$\text{C}_{11}\text{H}_{14}$	α , α , β -Trimethylstyrene.....	19.8	0.8970	1.51494	1.51997	1.53217	1.54311	(43)
$\text{C}_{11}\text{H}_{14}\text{Cl}_2$	1-Dichloro-2- <i>p</i> -tolylbutane.....	19.8	1.1117	1.52404	1.52827	1.53900	1.54787	(13)
$\text{C}_{11}\text{H}_{14}\text{Cl}_2$	1, 2, 3-Trimethyl-5-(β , β -dichloroethyl)-benzene.....	21.8	1.1424	1.53900	1.54310	1.55494		(89)
$\text{C}_{11}\text{H}_{14}\text{N}_2$	1- <i>n</i> -Butylindazole.....	17.2	1.0215	1.54889	1.55466*	1.56943	1.58663	(60)
$\text{C}_{11}\text{H}_{14}\text{N}_2$	2- <i>n</i> -Butylindazole.....	17.1	1.0274	1.55743	1.56358*	1.57944	1.59688	(60)
$\text{C}_{11}\text{H}_{14}\text{N}_2$	2, 3-Diethylindazole.....	19.1	1.0395	1.57254	1.57952*	1.59762	1.61596	(60)
$\text{C}_{11}\text{H}_{14}\text{O}$	α - <i>p</i> -Butenylanisole.....	19	0.9797	1.5426	1.5559	1.5733	1.6096	(132)
$\text{C}_{11}\text{H}_{14}\text{O}$	Ethylchavicol.....	12.2	0.961	1.5133	1.5179	1.5299	1.5400	(128)
$\text{C}_{11}\text{H}_{14}\text{O}$	Isobutyl phenyl ketone.....	15.3	0.9710	1.50917	1.51385	1.52574	1.53611	(8)
$\text{C}_{11}\text{H}_{14}\text{O}$	<i>tert</i> -Butyl phenyl ketone.....	19.2	0.9678	1.50427	1.50857	1.51971	1.52964	(8)
$\text{C}_{11}\text{H}_{14}\text{O}$	2, 4, 5-Trimethylacetophenone.....	14.9	1.0037	1.53572	1.54111	1.55525	1.56815	(8)
$\text{C}_{11}\text{H}_{14}\text{O}$	<i>p</i> -Isobutyrotoluene.....	21.2	0.9682	1.51366	1.51873	1.53167	1.54352	(41)
$\text{C}_{11}\text{H}_{14}\text{O}$	3-Isopropenyl-4-methoxytoluene.....	17.6	0.9661	1.52567	1.53083	1.54450	1.55686	(14)
$\text{C}_{11}\text{H}_{14}\text{O}$	<i>o</i> -Propenyl- <i>p</i> -methoxytoluene.....	12.25	0.9856	1.54948	1.55573	1.57349	1.59021	(14)
$\text{C}_{11}\text{H}_{14}\text{O}$	2', 2', 5-Trimethyl-2-hydroxystyrene....	21.5	0.9912	1.54430	1.55013	1.56502	1.57869	(14)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ²⁰	α	D	β	γ	Lit.
C ₁₁ H ₁₄ O	<i>sym.-m</i> -Xylenyl allyl ether.....	11.6	0.9548	1.51297	1.51793	1.52942	1.54006	(47)
C ₁₁ H ₁₄ O	<i>asym.-</i> Propionyl- <i>o</i> -xylene.....	15.1	0.8749	1.49925	1.50294	1.51375	1.52277	(89)
C ₁₁ H ₁₄ O ₂	<i>m</i> -Propio- <i>p</i> -methoxytoluene.....	18.9	1.0484	1.52638	1.53179	1.54650	1.56045	(41)
C ₁₁ H ₁₄ O ₂	<i>o</i> -Isobutyro- <i>o</i> -eresol.....	20.4	1.0468	1.53019	1.53663*	1.55395	1.57256	(40)
C ₁₁ H ₁₄ O ₂	<i>o</i> -Isobutyro- <i>m</i> -eresol.....	13.3	1.0485	1.53656	1.54308*	1.56091	1.57931	(30)
C ₁₁ H ₁₄ O ₂	<i>o</i> -Isobutyro- <i>p</i> -eresol.....	21.3	1.0425	1.52912	1.53550	1.55364	1.57256	(41)
C ₁₁ H ₁₄ O ₂	<i>p</i> -Isobutyroanisole.....	16.6	1.0498	1.53328	1.53925	1.55489	1.56926	(41)
C ₁₁ H ₁₄ O ₂	<i>o</i> -Isobutyro- <i>asym.-m</i> -xylenol.....	14	1.0334	1.52910	1.53555*	1.55321	1.57189	(40)
C ₁₁ H ₁₄ O ₂	Methyleugenol.....	11	1.041	1.5328	1.5373	1.5511	1.5631	(128)
C ₁₁ H ₁₄ O ₂	Methylisoeugenol.....	11.5	1.064	1.5649	1.5720	1.5911	1.6096	(128)
C ₁₁ H ₁₄ O ₂	<i>o</i> -Tolyl isobutyrate.....	16.6	1.0036	1.48874	1.49262*	1.50222	1.51040	(40)
C ₁₁ H ₁₄ O ₂	Ethyl hydrocinnamate.....	20	1.0147	1.49150	1.49542	1.50476	1.51277	(92)
C ₁₁ H ₁₄ O ₃	<i>o</i> -(α-Hydroxyisobutyro)- <i>p</i> -eresol.....	54.0	1.0943	1.52824	1.53470	1.55342	1.57053	(11)
C ₁₁ H ₁₄ O ₃	<i>o</i> -(α-Hydroxypropionyl)- <i>p</i> -methoxytoluene.....	19.2	1.0994	1.52158	1.52630	1.53963		(72)
C ₁₁ H ₁₄ O ₃	Ethyl <i>o</i> -toloxyacetate.....	12.9	1.0848	1.50249	1.50608	1.51669	1.52554	(16)
C ₁₁ H ₁₄ O ₃	Methyl <i>o</i> -methoxyhydrocinnamate....	18.4	1.0954	1.50848	1.51260	1.52320	1.53246	(16)
C ₁₁ H ₁₄ O ₄	α-Hydroxypropionylhydroquinol dimethyl ether.....	13.4	1.1486	1.53031	1.53527	1.54999		(72)
C ₁₁ H ₁₄ O ₆	Diethyl succinylmalonate.....	73.0	1.1675	1.46923	1.47245	1.48170	1.48952	(36)
C ₁₁ H ₁₆	<i>p-tert.</i> -Butyltoluene.....	13.25	0.8667	1.49118	1.49465	1.50513	1.51400	(13)
C ₁₁ H ₁₆	1, 1-Dimethylpropene-2, 5-cyclohexadiene.....	15.2	0.8618	1.50189	1.50633	1.51925	1.53040	(89)
C ₁₁ H ₁₆	<i>sym.</i> -Ethylpseudocumene.....	12.05	0.8938	1.51078	1.51474	1.52580	1.53481	(89)
C ₁₁ H ₁₆	2-Methyleymene.....	15.5	0.8740	1.49601	1.50001	1.51030	1.51913	(143)
C ₁₁ H ₁₆	2-Methylmenthatriene.....	15	0.8776	1.49803	1.50217	1.51260	1.52188	(143)
C ₁₁ H ₁₆	Pentamethylbenzene.....	72.8	0.8786	1.50104	1.50489	1.51609		(89)
C ₁₁ H ₁₆	<i>asym.</i> -Propyl- <i>o</i> -xylene.....	12.7	0.8719	1.49504	1.49881	1.50920	1.51784	(89)
C ₁₁ H ₁₆	1, 1, 3-Trimethyl-4-ethene-2, 5-cyclohexadiene.....	12.7	0.8844	1.51470	1.51931	1.53230	1.54371	(89)
C ₁₁ H ₁₆	1, 2, 5-Trimethyl-4-ethylbenzene.....	15.75	0.8867	1.50654	1.51047	1.52163	1.53112	(20)
C ₁₁ H ₁₆	1, 3, 5-Trimethyl-2-ethylbenzene.....	16.35	0.8885	1.50875	1.51274	1.52416	1.53376	(20)
C ₁₁ H ₁₆	1, 1, 2, 6-Tetramethyl-4-methene-2, 5-cyclohexadiene.....	23.2	0.8766	1.50884	1.51350	1.52660	1.53830	(89)
C ₁₁ H ₁₆	1, 1, 3, 6-Tetramethyl-4-methene-2, 5-cyclohexadiene.....	15.2	0.8809	1.51235	1.51687	1.53006	1.54172	(89)
C ₁₁ H ₁₆ Cl ₂ O	1-Isopropyl-4-methyl-4-dichloromethyl-1-cyclohexen-3-one.....	15.8	1.1654	1.51343	1.51769	1.52677	1.53540	(52)
C ₁₁ H ₁₆ Cl ₂ O	1-Isopropyl-4-methyl-4-dichloromethyl-5-cyclohexen-3-one.....	16.8	1.1421	1.49798	1.50142	1.50877	1.51532	(52)
C ₁₁ H ₁₆ O	Carvacrol methyl ether.....	23	0.9385	1.50126	1.50518	1.51603	1.52566	(47)
C ₁₀ H ₁₆ O	Citral.....	17	0.8897	1.48506	1.48945	1.50073	1.51081	(44)
C ₁₀ H ₁₆ O	Cyclocitral.....	13.3	0.9566	1.49341	1.49707	1.50689	1.51575	(44)
C ₁₁ H ₁₆ O	<i>o</i> -Ethyl- <i>sym.-m</i> -xylenyl methyl ether....	12.8	0.9624	1.51322	1.51811	1.52949	1.53968	(47)
C ₁₁ H ₁₆ O	Hemimellitenyl ethyl ether.....	22.8	0.9541	1.51054	1.51461	1.52608	1.53586	(47)
C ₁₁ H ₁₆ O	Mesityl ethyl ether.....	13.2	0.9364	1.49489	1.49859	1.50930	1.51834	(47)
C ₁₁ H ₁₆ O	Pseudocumenyl ethyl ether.....	14.95	0.9460	1.50705	1.51097	1.52247	1.53224	(47)
C ₁₁ H ₁₆ O	Thymol methyl ether.....	28	0.9332	1.49817	1.50240	1.50902	1.51322	(162)
C ₁₁ H ₁₆ O ₂	Ethyl 1-methyleyclohexene-1-methene-3-carboxylate.....	17.3		1.52646	1.53312	1.55148	1.56940	(45)
C ₁₁ H ₁₆ O ₄	Diethyl crotonylidenemalonate.....	16.7	1.0483	1.47803	1.48291*	1.49570		(27)
C ₁₁ H ₁₆ O ₄	Diethyl isoprenedicarboxylate.....	17.0	1.0586	1.49515	1.50081*	1.51560	1.52985	(27)
C ₁₁ H ₁₆ O ₆	Diethyl acetylmalonate <i>O</i> -acetate.....	14.95	1.1161	1.44877	1.45145	1.45925	1.46581	(34)
C ₁₁ H ₁₆ O ₆	Diethyl diacetylmalonate.....	17.0	0.9712	1.43037	1.43257		1.44255	(34, 105)
C ₁₁ H ₁₆ O ₇	Triethyl oxalylmalonate.....	16.1	1.1599	1.44666	1.44955	1.45742	1.46432	(35)
C ₁₁ H ₁₆ O ₈	Dimethyldiethyl methanetetra-carboxylate.....	17.2	1.1828	1.43098	1.43327	1.43891	1.44350	(35)
C ₁₁ H ₁₇ NO ₂	Ethyl tropidine-2-carboxylate.....	11.7	1.0721	1.49615	1.49930	1.50768	1.51462	(25)
C ₁₁ H ₁₇ NO ₃	Ethyl tropinone-2-carboxylate.....	20.8	1.1207	1.49225	1.49537	1.50432		(25)
C ₁₁ H ₁₇ NO ₄	Diethyl propyleyanomalonate.....	20	1.0332	1.4269	1.4291	1.4343	1.4388	(138)
C ₁₁ H ₁₈ O ₂	Diosphenol methyl ether.....	19.2	0.988	1.48405	1.48783*	1.49744	1.50601	(32)
C ₁₁ H ₁₈ O ₂	Ethyl α-cyclohexenepropionate.....	17.5	0.9683	1.46204	1.46459	1.47149	1.47683	(46)
C ₁₁ H ₁₈ O ₂	Ethyl isolauronolate.....	17.2	0.95339	1.46307	1.46624	1.47429	1.48127	(43)
C ₁₁ H ₁₈ O ₂	Ethyl hexylpropiolate.....	11.6	0.9154	1.44965	1.45227	1.4593	1.4648	(150)

Formula	Name	t , °C	d_4^t	α	D	β	γ	Lit.
C ₁₁ H ₁₈ O ₂	Ethyl 2-methylcyclohexylidene-1-acetate	14.8	0.9587	1.47524	1.47906	1.48816	1.49639	(46)
C ₁₁ H ₁₈ O ₂	Ethyl 3-methylcyclohexylidene-1-acetate	15.0	0.9571	1.47347	1.47730	1.48622	1.49464	(46)
C ₁₁ H ₁₈ O ₂	Ethyl 4-methylcyclohexylidene-1-acetate	17.0	0.9943	1.47013	1.47378	1.48311	1.49133	(46)
C ₁₁ H ₁₈ O ₂	Ethyl 2-methylcyclohexene-1-acetate...	18.4	0.9476	1.45125	1.45393		1.46639	(46)
C ₁₁ H ₁₈ O ₂	Ethyl 3-methylcyclohexene-1-acetate...	15.2	0.9506	1.45325	1.45592	1.46236	1.46844	(46)
C ₁₁ H ₁₈ O ₂	Methyl 1, 3-dimethylcyclohexylidene-5-acetate.....	15.0	0.9569	1.47252	1.47628	1.48477	1.49251	(84)
C ₁₁ H ₁₈ O ₂	Hydroxymethylenementhone.....	15.5	1.0010	1.49556	1.49997	1.51268	1.52496	(17, † 56)
C ₁₁ H ₁₈ O ₂	Methyl geranate.....	19.1	0.9220	1.46770	1.47143	1.48106	1.48929	(44)
C ₁₁ H ₁₈ O ₄	Diethyl <i>cis</i> - α , β -dimethylglutaconate...	20.3	1.0241	1.45039	1.45347*	1.46086	1.46731	(73)
C ₁₁ H ₁₈ O ₄	Diethyl <i>trans</i> - α , β -dimethylglutaconate...	19.3	1.0320	1.45079	1.45382*	1.46126	1.46771	(73)
C ₁₁ H ₁₈ O ₅	Diethyl acetylenylmalonate.....	19.25	1.0542	1.43185	1.43382	1.43971	1.44440	(34, † 105)
C ₁₁ H ₁₈ O ₅	Diethyl <i>n</i> -butyrylmalonate.....	22	1.0530	1.44113	1.44421	1.45132	1.45765	(56)
C ₁₁ H ₁₈ O ₅	Diethyl isobutyrylmalonate.....	19.0	1.0514	1.43801	1.44079	1.44786	1.45395	(56)
C ₁₁ H ₁₈ O ₅	Ethyl α -ethyl- β -hydroxycarboethoxy- α , β -crotonate.....	18	1.0579	1.44127	1.44396		1.45621	(43, † 105)
C ₁₁ H ₁₉ NO	Camphoroxime methyl ether.....	22.5	0.9578	1.47665	1.47949	1.48639	1.49216	(106)
C ₁₁ H ₁₉ NO ₂	Propionyltropein.....	19.6	1.0399	1.47208	1.47434	1.48069	1.48591	(25)
C ₁₁ H ₁₉ NO ₂	Ethyl tropane-2-carboxylate.....	20.5	1.0408	1.47272	1.47562	1.48197	1.48719	(25)
C ₁₁ H ₂₀ O	Bornyl methyl ether.....	23.4	0.9135	1.45992	1.46237	1.46838	1.47329	(97)
C ₁₁ H ₂₀ O	2, 6-Dimethyl-2, 8-nonadien-6-ol.....	16.6	0.8661	1.46154	1.46469	1.47208	1.47850	(71)
C ₁₁ H ₂₀ O	5-Ethyl-1, 8-nonadien-5-ol.....	20.7	0.8660	1.45945	1.46231	1.46942	1.47537	(71)
C ₁₁ H ₂₀ O ₂	Ethyl α , β -nonenate.....	19	0.8901	1.43972	1.44263*	1.44946	1.45544	(69)
C ₁₁ H ₂₀ O ₄	Diethyl diethylmalonate.....	16.6	0.9880	1.42308	1.42516	1.43044	1.43492	(9)
C ₁₁ H ₂₀ O ₄	Diethyl <i>fum.</i> - <i>sym.</i> -dimethylglutarate...	15.9	0.9807	1.42185	1.42402*	1.42912	1.43346	(73)
C ₁₁ H ₂₀ O ₄	Diethyl <i>mal.</i> - <i>sym.</i> -dimethylglutarate...	17.0	0.9824	1.42195	1.42419	1.42917	1.43342	(73)
C ₁₁ H ₂₀ O ₄	Diethyl trimethylsuccinate.....	16.7	0.9956	1.42659	1.42891*	1.43402	1.43840	(73)
C ₁₁ H ₂₁ N	<i>N</i> -Methylcamphidine.....	19.0	0.9011	1.47378	1.47625	1.48308	1.48869	(25)
C ₁₁ H ₂₂ N ₂	Diisoomylecyanamide.....	23.7	0.8461	1.43691	1.43915		1.44938	(106)
C ₁₁ H ₂₂ O	Methyl nonyl ketone.....	17.3	0.8295	1.42765	1.43002	1.43539	1.44099	(125)
C ₁₁ H ₂₂ O ₂	<i>n</i> -Decyl formate.....	20	0.8732	1.42484	1.42707	1.43217	1.43648	(163)
C ₁₁ H ₂₄ O	Methyl <i>n</i> -decyl ether.....	20	0.7973	1.41952	1.42177	1.42696	1.43126	(163)
C ₁₂ H ₈ O	Diphenylene oxide.....	99.3	1.0886	1.59964	1.60794	1.63272	1.65367	(48)
C ₁₂ H ₁₀	Acenaphthene.....	99.2	1.0242	1.59877	1.60658	1.62838		(48)
C ₁₂ H ₁₀	Diphenyl.....	77.1	0.9896	1.58112	1.58822	1.60760	1.62538	(48)
C ₁₂ H ₁₀ O	4-Methyl-1-naphthaldehyde.....	38.2	1.1252	1.63548	1.64567	1.67575	1.70698	(145)
C ₁₂ H ₁₀ O	Methyl α -naphthyl ketone.....	21.5	1.1171	1.61926	1.62796	1.65273	1.67686	(145)
C ₁₂ H ₁₀ O ₂	4-Methoxy-1-naphthaldehyde.....	43.7	1.1829	1.64151	1.65299	1.68748		(48)
C ₁₂ H ₁₂	1, 2-Dimethylnaphthalene.....	16.35	1.0219	1.61014	1.61795	1.63945	1.65976	(48)
C ₁₂ H ₁₂	1, 6-Dimethylnaphthalene.....	16.3	1.0049	1.60119	1.60886	1.63021	1.64958	(48)
C ₁₂ H ₁₂	Isobutylenephénylacetylene.....	13	0.9301	1.57675	1.58281	1.6046	1.61954	(150)
C ₁₂ H ₁₂ N ₂ O	2-Allylacetylindazole (stable).....	22.6	1.1172	1.56427	1.57070*	1.58716	1.60470	(33)
C ₁₂ H ₁₂ O	α -Ethoxynaphthalene.....	15.7	1.0643	1.59600	1.60351	1.62501	1.64508	(48, † 161)
C ₁₂ H ₁₂ O	β -Ethoxynaphthalene.....	47.3	1.0413	1.58602	1.59324	1.61409	1.63312	(48, † 161)
C ₁₂ H ₁₂ O ₂	Ethyl indene- β -carboxylate.....	73.9	1.0544	1.54126	1.54809	1.56773		(16)
C ₁₂ H ₁₂ O ₃	1, 4-Dimethyl-2-acetoxycoumarone.....	15.7	1.1361	1.53580	1.54080	1.55571	1.56884	(23)
C ₁₂ H ₁₂ O ₃	Ethyl 2-methylcoumarilate.....	56.6	1.1164	1.54133	1.54817	1.56657	1.58330	(41)
C ₁₂ H ₁₂ O ₃	Ethyl 5-methylcoumarilate.....	43.9	1.1187	1.54821	1.55575	1.57565	1.59513	(41)
C ₁₂ H ₁₂ O ₄	Ethyl benzoylformylacetate.....	24.9	1.1400	1.52561	1.53134	1.54631	1.55981	(105)
C ₁₂ H ₁₂ O ₄	Ethyl 2-methoxycoumarilate.....	70	1.1595	1.54280	1.54987	1.59611		(41)
C ₁₂ H ₁₂ O ₄	Ethyl 1-methylcoumaran-2-one-1-carboxylate.....	16.7	1.1919	1.53316	1.53902	1.55541	1.57176	(19)
C ₁₂ H ₁₂ S	α -(<i>o</i> -Methylbenzyl)-thiophene.....	12.1	1.0908	1.58392	1.58969*	1.60416	1.61692	(59)
C ₁₂ H ₁₃ ClO ₂	Ethyl β -chloro- α -(<i>p</i> -tolyl)-acrylate.....	19.7	1.1363	1.53053	1.53579	1.54962	1.56029	(3)
C ₁₂ H ₁₃ N	Dimethyl- α -naphthylamine.....	10.8	1.04694	1.61787	1.62609	1.65158	1.67629	(161)
C ₁₂ H ₁₃ N	Dimethyl- β -naphthylamine.....	53.2		1.63291	1.64432	1.67682	1.71289	(161)
C ₁₂ H ₁₃ N	α -Ethylaminonaphthalene.....	15.1	1.0652	1.63758	1.64773	1.67799	1.71062	(145)
C ₁₂ H ₁₃ N	β -Ethylaminonaphthalene.....	21.3	1.0545	1.64389	1.65440	1.68469	1.71642	(145)
C ₁₂ H ₁₄	1-Phenyl-1-cyclohexene.....	14.2	0.9905	1.56612	1.57157	1.58679	1.60026	(83)
C ₁₂ H ₁₄	1-Phenyl-1, 3-hexadiene.....	12	0.9253	1.59164	1.60252	1.62999	1.65874	(45, † 142)
C ₁₂ H ₁₄ Cl ₂ O ₂	Ethyl 1-methyl-1-dichloromethyl-2, 5-cyclohexadiene-4-methenecarboxylate..	22.1	1.2150	1.56171	1.56911	1.58984		(3)
C ₁₂ H ₁₄ Cl ₂ O ₂	Ethyl β , β -dichloro- α -(<i>p</i> -tolyl)-propionate	18.7	1.2017	1.51729	1.52137	1.53173	1.54070	(3)
C ₁₂ H ₁₄ N ₂	1-Benzyl-3, 5-dimethylpyrazole.....	15.0	1.0383	1.54628	1.55113*	1.56292	1.57312	(60)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ^{<i>t</i>}	α	D	β	γ	Lit.
C ₁₂ H ₁₄ N ₂	1-Phenyl-3, 4, 5-trimethylpyrazole.....	18.7	1.0453	1.56543	1.57152*	1.58685	1.60080	(60)
C ₁₂ H ₁₄ N ₂ O	2-Isovalerylindazole (stable).....	16.3	1.0879	1.54870	1.55466*	1.57012	1.58451	(33)
C ₁₂ H ₁₄ N ₂ O ₂	Ethyl 1-ethylindazole-3-carboxylate.....	17.3	1.1431	1.55924	1.56587*	1.58318	1.59991	(29)
C ₁₂ H ₁₄ N ₂ O ₂	Ethyl 2-ethylindazole-3-carboxylate.....	22.8	1.1289	1.56355	1.57123*	1.59221	1.61255	(29)
C ₁₂ H ₁₄ O	<i>o</i> , <i>o</i> -Diallylphenol.....	15.4	0.9918	1.53676	1.54163	1.55480	1.56579	(47)
C ₁₂ H ₁₄ O	α -Benzalmethyl propyl ketone.....	17.5	0.9978	1.56235	1.57046	1.59316	1.61594	(8)
C ₁₂ H ₁₄ O	α -Benzalmethyl isopropyl ketone.....	24.6	0.9858	1.55870	1.56693	1.59000	1.61338	(8)
C ₁₂ H ₁₄ O	5, 7-Dimethyl-1-ketotetrahydronaphthalene.....	15.5	1.0654	1.55986	1.56496	1.57971	1.59284	(146)
C ₁₂ H ₁₄ O	7-Ethyl-1-ketotetrahydronaphthalene...	17.2	1.0556	1.55478	1.55988	1.57454	1.58752	(146)
C ₁₂ H ₁₄ O	<i>o</i> -Allylphenyl allyl ether.....	15.0	0.9676	1.52188	1.52634	1.53900	1.54981	(47)
C ₁₂ H ₁₄ O	1, 4-Dimethyl-2-ethylcoumarone.....	11.4	1.0108	1.54187	1.54715	1.56233	1.57583	(23)
C ₁₂ H ₁₄ O	2, 4, 6-Trimethyl- α -chromene.....	14.25	1.0172	1.54841	1.55389	1.56984	1.58443	(23)
C ₁₂ H ₁₄ O	3, 4, 6-Trimethyl- α -chromene.....	15.2	1.0336	1.55407	1.55968	1.57565		(23)
C ₁₂ H ₁₄ O ₂	Butyrylacetophenone.....	21.0	1.0478	1.56208	1.57075	1.59629	1.62394	(56)
C ₁₂ H ₁₄ O ₂	Diethylphthalide.....	61.6	1.0403	1.50385	1.50872	1.51905		(49)
C ₁₂ H ₁₄ O ₂	1, 4-Dimethyl-1-ethylcoumaranone.....	19.6	1.0559	1.53023	1.53604	1.55356	1.57169	(19)
C ₁₂ H ₁₄ O ₂	1-Ethyl-3, 5-dimethylcoumaranone.....	20.5	1.0667	1.53689	1.54240	1.55907	1.57403	(66)
C ₁₂ H ₁₄ O ₂	1-Isopropyl-4-methylcoumaranone.....	13.8	1.0707	1.53692	1.54286	1.56046	1.57857	(19)
C ₁₂ H ₁₄ O ₂	5-Methyl-2- <i>n</i> -propylcoumaranone.....	16.8	1.0675	1.53967	1.54589	1.56268	1.58066	(85)
C ₁₂ H ₁₄ O ₂	1, 1, 3, 5-Tetramethylcoumaranone.....	18.2	1.0620	1.53765	1.54359	1.56110	1.57820	(66)
C ₁₂ H ₁₄ O ₂	Ethyl α -methylcinnamate.....	20.6	1.0321	1.54074	1.54753	1.56500	1.58162	(45)
C ₁₂ H ₁₄ O ₂	Ethyl β -methylcinnamate.....	16.6	1.0392	1.53930	1.54558	1.56165	1.57654	(14, 45†)
C ₁₂ H ₁₄ O ₂	Ethyl <i>o</i> -methylcinnamate.....	16.3	1.0428	1.54852	1.55552	1.57593	1.59533(?)	(14)
C ₁₂ H ₁₄ O ₂	Ethyl <i>p</i> -methylcinnamate.....	15.9	1.0340	1.55503	1.56302	1.58531	1.60748	(8, † 14)
C ₁₂ H ₁₄ O ₂	Methyl α , <i>p</i> -dimethylcinnamate.....	18.3	1.0507	1.55635	1.56400	1.58432	1.60362	(14)
C ₁₂ H ₁₄ O ₂	Methyl β , <i>p</i> -dimethylcinnamate.....	60.2	1.0144	1.53389	1.54084	1.55926		(14)
C ₁₂ H ₁₄ O ₃	5-Methyl-2-methoxybenzoylacetone....	17.9	1.1196	1.57582	1.58562	1.61562		(66)
C ₁₂ H ₁₄ O ₃	1, 4-Dimethyl-1-ethoxycoumaranone....	14.05	1.1030	1.52654	1.53217	1.54976	1.56849	(12, 19†)
C ₁₂ H ₁₄ O ₃	Methyl <i>p</i> -tolylidiketone ethyl ether....	65.0	1.0524	1.50733	1.51270	1.52888		(18)
C ₁₂ H ₁₄ O ₃	Ethyl β -phenylmethylglycidate.....	16.7	1.0936	1.50197	1.50603	1.51569		(16)
C ₁₂ H ₁₄ O ₃	Ethyl 1-methylcoumarane-4-carboxylate	14.3	1.1179	1.53045	1.53626	1.55037	1.56357	(16)
C ₁₂ H ₁₄ O ₃	Ethyl <i>p</i> -methoxycinnamate.....	59.2	1.0664	1.55317	1.56193	1.58829		(14)
C ₁₂ H ₁₄ O ₃	Methyl allo- β -methyl- <i>o</i> -methoxycinnamate.....	17.0	1.0978	1.53346	1.53897	1.55282	1.56547	(14)
C ₁₂ H ₁₄ O ₃	Methyl α -methyl- <i>o</i> -methoxycinnamate..	15.2	1.1261	1.56466	1.57207	1.59347		(14)
C ₁₂ H ₁₄ O ₃	Methyl β -methyl- <i>o</i> -methoxycinnamate..	16.65	1.1037	1.54267	1.54881	1.56490	1.57991	(14)
C ₁₂ H ₁₄ O ₄	Apiol.....	14	1.176	1.5330	1.5380	1.5510	1.5619	(128)
C ₁₂ H ₁₄ O ₄	Isapiol.....	12	1.197	1.5639	1.5703	1.5892	1.6062	(128)
C ₁₂ H ₁₄ O ₄	Diethyl phthalate.....	17.7	1.1203	1.49890	1.50293	1.51356	1.52284	(80, † 104, 145)
C ₁₂ H ₁₄ O ₄	Diethyl isophthalate.....	17.5	1.1232	1.50361	1.50815	1.51938		(80)
C ₁₂ H ₁₆	β , β -Diethylstyrene.....	18.7	0.8924	1.51199	1.51677	1.52837	1.53866	(43)
C ₁₂ H ₁₆	<i>ar</i> .-1, 3-Dimethyltetrahydronaphthalene	21.0	0.9589	1.53683	1.54094	1.55287	1.56297	(146)
C ₁₂ H ₁₆	<i>ar</i> .-2-Ethyltetrahydronaphthalene.....	17.6	0.9499	1.53072	1.53474	1.54627	1.55594	(146)
C ₁₂ H ₁₆	α -Ethyl- β , β -dimethylstyrene.....	17.5	0.8886	1.50950	1.51422	1.52569	1.53575	(43)
C ₁₂ H ₁₆ N ₂	1-Isoamylindazole.....	16.3	1.0047	1.54160	1.54724	1.56138	1.57470	(60)
C ₁₂ H ₁₆ N ₂	2-Isoamylindazole.....	18.5	1.0084	1.55248	1.55877*	1.57452	1.58954	(60)
C ₁₂ H ₁₆ N ₂	Propylpropenyl- <i>o</i> -phenylenediamine....	20.8	1.0341	1.55712	1.56255	1.57687	1.58971	(109)
C ₁₂ H ₁₆ O	<i>o</i> -Allyl- <i>sym</i> .- <i>m</i> -xylenyl allyl ether.....	12.8	0.9666	1.52228	1.52750	1.53938	1.55029	(47)
C ₁₂ H ₁₆ O	2', 2', 5-Trimethyl-2-hydroxystyrene methyl ether.....	17.05	0.9679	1.53681	1.54253	1.55778	1.57181	(14)
C ₁₂ H ₁₆ O ₂	<i>o</i> -Isovalero- <i>p</i> -cresol.....	18.4	1.0291	1.52683	1.53270	1.55001	1.56848	(65)
C ₁₂ H ₁₆ O ₂	<i>o</i> -Isobutyro- <i>p</i> -methoxytoluene.....	13.7	1.0240	1.51685	1.52175	1.53545	1.54811	(41)
C ₁₂ H ₁₆ O ₂	Ethyleugenol.....	9.5	1.021	1.5256	1.5301	1.5426	1.5529	(128)
C ₁₂ H ₁₆ O ₂	Ethylisoeugenol.....	11	1.044	1.5540	1.5607	1.5792	1.5993	(128)
C ₁₂ H ₁₆ O ₂	Ethylchavibetol.....	11.5	1.013	1.5232	1.5276	1.5403	1.5514	(128)
C ₁₂ H ₁₆ O ₂	Ethylisochavibetol.....	11	1.039	1.5539	1.5602	1.5792	1.5980	(128)
C ₁₂ H ₁₆ O ₂	Amyl benzoate.....	17.4	0.9910	1.49114	1.49498	1.50530	1.51420	(145)
C ₁₂ H ₁₆ O ₂	Ethyl γ -phenylbutyrate.....	19.45	1.0015	1.49028	1.49396	1.50317	1.51110	(70)
C ₁₂ H ₁₆ O ₃	Asaron.....	11	1.091	1.5648	1.5719	1.5931	1.6142	(128)
C ₁₂ H ₁₆ O ₃	Ethyl 3-methyl-4-ethoxybenzoate.....	15.1	1.0618	1.51443	1.51908	1.53259	1.54428	(16)
C ₁₂ H ₁₈	2-Ethylcymene.....	15.6	0.8708	1.49494	1.49878	1.50878	1.51739	(143)
C ₁₂ H ₁₈	2-Ethylmenthatriene.....	15	0.8880	1.50429	1.50847	1.51920	1.52763	(143)
C ₁₂ H ₁₈	1, 1, 3, 6-Tetramethyl-4-ethene-2, 5-cyclohexadiene.....	15.4	0.8837	1.51028	1.51452	1.52702	1.53796	(89)

Formula	Name	$t, ^\circ\text{C}$	d_4^t	α	D	β	γ	Lit.
$\text{C}_{12}\text{H}_{18}\text{N}_2\text{O}_2$	2-Carbethoxy-7-methyltetrahydroindazole	21.8	1.0911	1.50218	1.50555*	1.51363	1.52027	(60)
$\text{C}_{12}\text{H}_{18}\text{O}_2$	Acetylcamphor.....	17.9	1.0314	1.49077	1.49415	1.50284	1.51057	(11 ^c)
$\text{C}_{12}\text{H}_{18}\text{O}_2$	Methoxymethylenecamphor.....	15.2	1.0234	1.50524	1.50913	1.51997	1.52986	(17)
$\text{C}_{12}\text{H}_{18}\text{O}_2$	Methylformylcamphor.....	23.1	1.0214	1.50118	1.50513		1.52376	(105)
$\text{C}_{12}\text{H}_{18}\text{O}_2$	Ethyl 1, 5-dimethylcyclohexene-1-meth- ene-3-carboxylate.....	20.6	0.9701	1.51237	1.51848	1.53424	1.54950	(45)
$\text{C}_{12}\text{H}_{18}\text{O}_3$	Diosphenol acetate.....	14.6	1.0415	1.48027	1.48378*	1.49233	1.49996	(32)
$\text{C}_{12}\text{H}_{18}\text{O}_3$	Ethyl diallylacetoacetate.....	17.4	0.9823	1.45426	1.45716		1.47001	(105)
$\text{C}_{12}\text{H}_{18}\text{O}_3$	Ethyl isophoronecarboxylate.....	20.4	1.0291	1.47539	1.47878	1.48732	1.49738	(43,† 44)
$\text{C}_{12}\text{H}_{18}\text{O}_3$	Methyl camphocarboxylate.....	18.0	1.0847	1.48080	1.48333	1.48945	1.49461	(113,† 122)
$\text{C}_{12}\text{H}_{18}\text{O}_4$	Dimethyl <i>d</i> -dehydrocamphorate.....	18.1	1.0881	1.47078	1.47363	1.48096	1.48724	(9)
$\text{C}_{12}\text{H}_{18}\text{O}_4$	Dimethyl isodehydrocamphorate.....	17.5	1.0851	1.46526	1.46782	1.47434	1.47988	(9)
$\text{C}_{12}\text{H}_{18}\text{O}_6$	Diethyl propionylmalonate <i>O</i> -acetate...	16.7	1.0983	1.44937	1.45211	1.45972	1.46611	(34)
$\text{C}_{12}\text{H}_{18}\text{O}_6$	Diethyl acetylmalonate <i>O</i> -propionate...	18.6	1.0984	1.44918	1.45191	1.45967	1.46627	(34)
$\text{C}_{12}\text{H}_{18}\text{O}_6$	Triethyl aconitate.....	20	1.1064	1.45255	1.45562	1.46325	1.46981	(45,† 95)
$\text{C}_{12}\text{H}_{18}\text{O}_7$	Diethyl <i>O</i> -carbethoxy- β -hydroxyethyl- denemalonate.....	15.1	1.1322	1.44787	1.45059	1.45802	1.46436	(35)
$\text{C}_{12}\text{H}_{18}\text{O}_7$	Triethyl acetylmetanetricarboxylate...	13.5	1.1283	1.43456	1.43658	1.44257	1.44722	(35)
$\text{C}_{12}\text{H}_{20}\text{O}$	Ethylcamphor.....	24.3	0.9340	1.46624	1.46864	1.47453	1.47938	(97)
$\text{C}_{12}\text{H}_{20}\text{O}_2$	1, 1, 3, 3-Tetraethyl-2, 4-diketocyclo- butane.....	17.75	0.9456	1.44962	1.45181	1.45803	1.46295	(18)
$\text{C}_{12}\text{H}_{20}\text{O}_2$	Diosphenol ethyl ether.....	19.0		1.48405	1.48788*	1.49743	1.50601	(32)
$\text{C}_{12}\text{H}_{20}\text{O}_2$	Bornyl acetate.....	22.6	0.9833	1.45998	1.46225	1.46827	1.47319	(25)
$\text{C}_{12}\text{H}_{20}\text{O}_2$	Isobornyl acetate.....	23.4	0.9807	1.45978	1.46191	1.46798	1.47275	(25)
$\text{C}_{12}\text{H}_{20}\text{O}_2$	Ethyl 1, 3-dimethyl-4-cyclohexene-5- acetate.....	13.8	0.9455	1.45901	1.46178	1.46869	1.47458	(84)
$\text{C}_{12}\text{H}_{20}\text{O}_2$	Ethyl 1, 3-dimethylcyclohexylidene-5- acetate.....	20.3	0.9374	1.45481	1.45753	1.46416	1.46965	(84)
$\text{C}_{12}\text{H}_{20}\text{O}_3$	Ethyl 1, 3-dimethyl-3-cyclohexene-5- hydroxy-5-acetate.....	17.6		1.46857	1.47133	1.47829	1.48411	(76)
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Diethyl <i>cis</i> - β -methyl- α -ethylglutaconate.	20.9	1.0182	1.45168	1.45487*	1.46256	1.46929	(73)
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Diethyl <i>trans</i> - β -methyl- α -ethylglutacon- ate.....	19.9	1.0143	1.44984	1.45292*	1.46017	1.46658	(73)
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Diethyl <i>cis</i> -hexahydrophthalate.....	16.8	1.0570	1.45207	1.45451	1.45992	1.46460	(73)
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Diethyl <i>trans</i> -hexahydrophthalate.....	14.4	1.0449	1.44996	1.45235*	1.45791	1.46268	(73)
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Diethyl <i>cis</i> -hexahydroisophthalate.....	14.1	1.0505	1.45176	1.45414*	1.45970	1.46431	(73)
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Diethyl <i>cis</i> -hexahydroterephthalate.....	20.6	1.0516	1.44978	1.45222*	1.45769	1.46237	(73)
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Dimethyl camphorate.....	16.9	1.0774	1.46098	1.46334		1.47366	(99)
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Ethyl acid camphorate.....	16.8	1.10235	1.47126	1.47372	1.47955	1.48431	(97)
$\text{C}_{12}\text{H}_{20}\text{O}_5$	Diethyl isovalerylmalonate.....	21.0	1.0331	1.44138	1.44429	1.45156	1.45793	(56)
$\text{C}_{12}\text{H}_{20}\text{O}_7$	Triethyl citrate.....	20	1.1369	1.44302	1.44554	1.45133	1.45609	(93)
$\text{C}_{12}\text{H}_{21}\text{NO}$	Camphoroxime ethyl ether.....	17.0	0.9473	1.47574	1.47853		1.49122	(106)
$\text{C}_{12}\text{H}_{22}\text{N}_2$	γ -Ethylenedipiperidine.....	17.8	0.9212	1.48570	1.48869	1.49603	1.50219	(106)
$\text{C}_{12}\text{H}_{22}\text{O}$	1, 1-Dimethyl-4, 4-diethyl-cyclohexan-2- one.....	15.2	0.9112	1.46086	1.46307	1.46914	1.47419	(68)
$\text{C}_{12}\text{H}_{22}\text{O}$	Bornyl ethyl ether.....	24.7	0.8969	1.45329	1.45554	1.46131	1.46591	(97)
$\text{C}_{12}\text{H}_{22}\text{O}_2$	Amylpropionic acetal.....	9.5	0.8858	1.43980	1.44210	1.4483	1.45307	(150)
$\text{C}_{12}\text{H}_{22}\text{O}_2$	Ethyl 2-methyl-5-isopropylcyclopentane- 1-carboxylate.....	11.8	0.9178	1.44047		1.44825	1.45272	(130)
$\text{C}_{12}\text{H}_{22}\text{O}_4$	Ethyl β -amyl- β -ethoxyacrylate.....	23.2	0.9307	1.44865	1.45179	1.45996	1.46716	(17)
$\text{C}_{12}\text{H}_{22}\text{O}_3$	Ethyl 1, 3-dimethylcyclohexan-5-ol-5- acetate.....	14.9	0.9895	1.45442	1.45664	1.46269	1.46777	(84)
$\text{C}_{12}\text{H}_{22}\text{O}_4$	Bis-diethylacetal.....	26	0.9529	1.4289	1.43276	1.4386	1.4432	(150)
$\text{C}_{12}\text{H}_{22}\text{O}_4$	Diethyl tetramethylsuccinate.....	22.7	0.9928	1.43246	1.43484*	1.44001	1.44450	(73)
$\text{C}_{12}\text{H}_{23}\text{NO}_2$	Ethyl <i>cis</i> - <i>p</i> -amino- <i>o</i> , <i>o</i> , <i>o'</i> -trimethyl- hexahydrobenzoate.....	21.1	0.9888	1.47188	1.47493*	1.48167	1.48776	(73)
$\text{C}_{12}\text{H}_{23}\text{NO}_2$	Ethyl <i>trans</i> - <i>p</i> -amino- <i>o</i> , <i>o</i> , <i>o'</i> -trimethyl- hexahydrobenzoate.....	21.1	0.9789	1.46938	1.47219*	1.47823	1.48356	(73)
$\text{C}_{12}\text{H}_{24}\text{N}_2\text{O}_4$	Diethylhydrazoisobutyrate.....	20.5	0.9985	1.43165	1.43403*	1.43941	1.44411	(29)
$\text{C}_{12}\text{H}_{24}\text{O}$	1, 1-Dimethyl-4, 4-diethylcyclohexan-2- ol.....	13.6	0.9196	1.47367	1.47588	1.48213	1.48715	(68)
$\text{C}_{12}\text{H}_{24}\text{O}$	Menthyl ethyl ether.....	17.1	0.8535	1.44125	1.44347	1.44897	1.45358	(97)
$\text{C}_{12}\text{H}_{24}\text{O}_2$	<i>n</i> -Decyl acetate.....	20	0.8671	1.42494	1.42727	1.43257	1.43698	(163)
$\text{C}_{12}\text{H}_{26}\text{O}$	Ethyl <i>n</i> -decyl ether.....	20	0.7942	1.42032	1.42227	1.42753	1.43173	(163)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ^{<i>t</i>}	α	D	β	γ	Lit.
C ₁₂ H ₂₇ N	Triisobutylamine.....	17.3	0.7711	1.42280	1.42519		1.43571	(106)
C ₁₂ H ₂₇ N ₃	Triformalpropylamine.....	18.8	0.8795	1.45712	1.45974	1.46630	1.47171	(109)
C ₁₃ H ₁₀ O	Benzophenone:							
	(Stable).....	45.2	1.0889	1.58932	1.59750	1.61615		(45)
	(Labile).....	23.4	1.1076	1.59836	1.60596	1.62519	1.64190	(45)
C ₁₃ H ₁₂	Diphenylmethane.....	20	1.0060	1.57145	1.57683	1.59183	1.60483	(48)
C ₁₃ H ₁₂ O	1-Methyl-2-acetylnaphthalene.....	16.1	1.1046	1.61816	1.62695	1.65215	1.67720	(145)
C ₁₃ H ₁₂ O	2-Methyl-(5)8-acetylnaphthalene.....	13.3	1.0985	1.61572	1.62443	1.64933	1.67405	(145)
C ₁₃ H ₁₂ O ₂	Ethyl 1-naphthoate.....	14.7	1.1270	1.58914	1.59660	1.61774	1.63770	(48, 161)
C ₁₃ H ₁₂ O ₂	Ethyl 2-naphthoate.....	22.7	1.1143	1.58756	1.59513	1.61649	1.63543	(48)
C ₁₃ H ₁₂ O ₂	Methyl 6-methyl-1-naphthoate.....	15.3	1.1400	1.60027	1.60813	1.63056		(48)
C ₁₃ H ₁₃ N	Benzylaniline.....	24.8	1.0619	1.5974	1.6118	1.6301	1.6663(?)	(132)
C ₁₃ H ₁₃ N	Methyldiphenylamine.....	24.6	1.0466	1.5998	1.6166	1.6391	1.6774	(132)
C ₁₃ H ₁₄	1-Methyl-2-ethylnaphthalene.....	15.4	1.0014	1.59422	1.60138	1.62151	1.63995	(145)
C ₁₃ H ₁₄	1-Methyl-4-ethylnaphthalene.....	13.1	1.0086	1.59839	1.60571	1.62624	1.64490	(145)
C ₁₃ H ₁₄ N ₂	1-Phenyltetrahydroindazole.....	99.9	1.0608	1.56243	1.56821*	1.58313	1.59647	(60)
C ₁₃ H ₁₄ N ₂	2-Phenyltetrahydroindazole.....	99.6	1.0544	1.57181	1.57840*	1.59640	1.61353	(60)
C ₁₃ H ₁₄ O	1-Benzyl-5-cyclohexen-2-one.....	21.65	1.0612	1.55746	1.56277	1.57641	1.58865	(83)
C ₁₃ H ₁₄ O ₂	2, 2-Diethylindanedione.....	14.5	1.0693	1.53658	1.54174	1.55632	1.56967	(36)
C ₁₃ H ₁₄ O ₂	Ethyl allocinnamylideneacetate.....	18.5	1.0445	1.60619	1.61925*	1.65711	1.70021	(27)
C ₁₃ H ₁₄ O ₂	Ethyl einnamylideneacetate.....	42.2	1.0294	1.60039	1.61348*	1.65080	1.69311	(27)
C ₁₃ H ₁₄ O ₂	Ethyl γ -methy lindene- β -carboxylate....	39.1	1.0740	1.55417	1.56087	1.58022	1.59885	(16)
C ₁₃ H ₁₄ O ₂	Ethyl Δ^1 -dihydro- β -naphthoate.....	18	1.0950	1.57134	1.57919	1.60038	1.62169	(70)
C ₁₃ H ₁₄ O ₂	Ethyl Δ^2 -dihydro- α -naphthoate (labile)..	19.6	1.0897	1.53057	1.53486*	1.54549	1.55458	(70)
C ₁₃ H ₁₄ O ₂	Ethyl Δ^1 -dihydro- α -naphthoate (stable)..	20.2	1.1019	1.55326	1.55896*	1.57328	1.58642	(70)
C ₁₃ H ₁₄ O ₂	Ethyl Δ^3 -dihydro- β -naphthoate.....	18.2	1.0865	1.54587	1.55133	1.56534	1.57811	(70)
C ₁₃ H ₁₄ O ₃	Ethyl 2, 4-dimethylcoumarilate.....	59	1.0931	1.53939	1.54642	1.56425	1.58147	(41)
C ₁₃ H ₁₄ O ₃	1-Ethyl-4-methyl-2-acetoxycoumarone..	18.7	1.1079	1.52993	1.53493	1.54952	1.56293	(23)
C ₁₃ H ₁₄ O ₄	Ethyl 1, 4-dimethylcoumaran-2-one-1-carboxylate.....	24.1	1.1533	1.52752	1.53340	1.55002	1.56719	(19)
C ₁₃ H ₁₄ O ₄	Ethyl 1-ethyleoumaran-2-one-1-carboxylate.....	18.6	1.1548	1.53082	1.53660	1.55289	1.56878	(19)
C ₁₃ H ₁₄ O ₄	Ethyl 2-ethoxyeoumarilate.....	14.3	1.1681	1.55231	1.55922	1.57818	1.59662	(41)
C ₁₃ H ₁₄ O ₄	Ethyl 4-methyl-2-methoxycoumarilate..	23.8	1.1701	1.55570	1.56279	1.58240	1.60172	(41)
C ₁₃ H ₁₅ BrO ₂	<i>o</i> -(α -Bromoisobutyro)- <i>p</i> -acetotoluene...	25.7	1.3173	1.52435	1.52883	1.54054		(11)
C ₁₃ H ₁₆	1-Benzyl-1-cyclohexene.....	14.1	0.9692	1.54009	1.54426	1.55601	1.56577	(83)
C ₁₃ H ₁₆	1-Phenyl-5-methyl-1, 3-hexadiene.....	20	0.9248	1.57822	1.58727	1.61401	1.64065	(45, † 142)
C ₁₃ H ₁₆ N ₂ O ₂	Isoamyl indazole-2-carboxylate.....	15.1	1.1101	1.53715	1.54251*	1.55586	1.56805	(29)
C ₁₃ H ₁₆ O	α -Benzalmethyl <i>n</i> -butyl ketone.....	44.7	0.9596	1.54416	1.55181	1.57293		(8)
C ₁₃ H ₁₆ O	1, 3-Dimethyl-6-isopropylcoumarone....	14.15	0.9993	1.53749	1.54273	1.55724	1.57032	(23)
C ₁₃ H ₁₆ O	1-Methyl-4- <i>tert</i> -butylcoumarone.....	13.85	0.9938	1.53326	1.53831	1.55213	1.56460	(23)
C ₁₃ H ₁₆ O ₂	<i>p</i> -Tolyl α -ethylcrotonate.....	14.6	1.0134	1.51112	1.51566*	1.52680	1.53675	(30)
C ₁₃ H ₁₆ O ₂	2, 2-Diethyl-5-methylcoumaranone.....	22.6	1.0320	1.52549	1.53141*	1.54797	1.56575	(30)
C ₁₃ H ₁₆ O ₂	1-Isopropyl-3, 5-dimethylcoumaranone..	21	1.0472	1.53396	1.53955	1.55610	1.57256	(66)
C ₁₃ H ₁₆ O ₂	2, 6-Dimethyl-3-ethylchromanone.....	21.0	1.0627	1.53330	1.53912*	1.55386	1.56988	(30)
C ₁₃ H ₁₆ O ₂	3, 4-Dimethyl-2-ethyl-7-oxyhydrindone..	12.2	1.0806	1.54590	1.55190*	1.56733	1.58263	(30)
C ₁₃ H ₁₆ O ₂	Ethyl α , β -dimethylcinnamate.....	15.2	1.0202	1.51620	1.52119	1.51903		(14)
C ₁₃ H ₁₆ O ₂	Ethyl α -ethylcinnamate.....	13.75	1.0247	1.53613	1.54252	1.55907	1.57473	(14)
C ₁₃ H ₁₆ O ₂	Isovalerylacetophenone.....	20.1	1.0307	1.55232	1.56044	1.58492	1.61114	(56)
C ₁₃ H ₁₆ O ₂	Phenylpropiolie acetal.....	13	0.9940	1.51725	1.52216	1.53373	1.54352	(150)
C ₁₃ H ₁₆ O ₃	Ethyl β -ethoxycinnamate.....	24.5	1.0593	1.52511	1.53072	1.54557	1.55949	(14)
C ₁₃ H ₁₆ O ₃	Ethyl ethylbenzoylacetate.....	13.7	1.0717	1.50663	1.51103	1.52221	1.53222	(17, † 56)
C ₁₃ H ₁₆ O ₃	Ethyl α -methyl- <i>p</i> -methoxycinnamate...	15.6	1.0894	1.56213	1.57009	1.59339		(37)
C ₁₃ H ₁₆ O ₃	Methyl α , <i>m</i> -dimethyl- <i>o</i> -methoxycinnamate.....	14.6	1.0989	1.55727	1.56424	1.58477		(14)
C ₁₃ H ₁₆ O ₃	Methyl β -methyl-2-methoxy-5-methylcinnamate.....	12.7	1.0872	1.54083	1.54716	1.56290	1.57804	(14)
C ₁₃ H ₁₆ O ₃	<i>o</i> -Isobutyro- <i>o</i> -tolyl acetate.....	18.4	1.0755	1.50985	1.51436*	1.52583	1.53613	(40)
C ₁₃ H ₁₇ NO	α -Mesityloxide oxime benzyl ether.....	14	0.9919	1.53035	1.53557*	1.54824	1.55961	(74)
C ₁₃ H ₁₇ NO ₂	Ethyl β -benzylaminoacetoacetate.....	21.6	1.0596	1.55119	1.55786	1.57546	1.59273	(109)
C ₁₃ H ₁₈ O	Thymol allyl ether.....	15.4	0.9390	1.50622	1.51025	1.52152	1.53110	(47)
C ₁₃ H ₁₈ O	<i>o</i> -Allylthymol.....	15.4	0.9700	1.52382	1.52809	1.53986	1.54992	(47)
C ₁₃ H ₁₈ O ₃	Ethyl α , <i>p</i> -toloxyisobutyrate.....	19.55	1.0270	1.48624	1.48945	1.49916	1.50720	(82)
C ₁₃ H ₁₈ O ₃	α -Hydroxydiethylaceto- <i>p</i> -cresol..	21.1	1.0796	1.53392	1.54040*	1.55820	1.57750	(30)

Formula	Name	t , °C	d_4^t	α	D	β	γ	Lit.
C ₁₃ H ₂₀	2-Propylcymene.....	15	0.8685	1.49198	1.49585	1.50549	1.51386	(143)
C ₁₃ H ₂₀	2-Propyl- $\Delta^{2,5,8,(9)}$ -menthatriene.....	15	0.8804	1.49900	1.50273	1.51312	1.52141	(143)
C ₁₃ H ₂₀ O	α -Ionone.....	22.3	0.9298	1.49452	1.49842	1.50834	1.51735	(44)
C ₁₃ H ₂₀ O	β -Ionone.....	18.9	0.9445	1.51443	1.51977	1.53396	1.54783	(45)
C ₁₃ H ₂₀ O	<i>o</i> , <i>o</i> -Diethyl- <i>sym</i> .- <i>m</i> -xylenyl methyl ether	14.4	0.9507	1.51035	1.51525	1.52546	1.53491	(47)
C ₁₃ H ₂₀ O ₂	Ethylformylcamphor.....	17.9	1.0036	1.50062	1.50465	1.51592	1.52473	(105)
C ₁₃ H ₂₀ O ₂	Propionylcamphor.....	18.1	1.0187	1.48729	1.49051	1.49857	1.50569	(119)
C ₁₃ H ₂₀ O ₂	Ethyl bornylenecarboxylate.....	19.8	0.9828	1.47284	1.47604	1.48332	1.48969	(9)
C ₁₃ H ₂₀ O ₂	Ethyl 1-methyl-4-isopropyl-1, 3-cyclohexadiene-3-carboxylate.....	16.9	0.9773	1.49592	1.50010	1.51100	1.52074	(54)
C ₁₃ H ₂₀ O ₃	Acetoxymethylenementhone.....	16.0	1.0318	1.48415	1.48754	1.49697	1.50520	(17)
C ₁₃ H ₂₀ O ₃	Ethyl camphorcarboxylate.....	24.3	1.0528	1.47106	1.47356	1.47962	1.48454	(97, 113)
C ₁₃ H ₂₀ O ₃	Ethyl methylisophoronecarboxylate....	19	1.0248	1.47760	1.48181	1.49023	1.49776	(44)
C ₁₃ H ₂₀ O ₄	Diethyl diallylmalonate.....	15.3	0.9961	1.44502	1.44771	1.45431	1.45977	(71)
C ₁₃ H ₂₀ O ₆	Diethyl propionylmalonate <i>O</i> -propionate	19.1	1.0790	1.44843	1.45106	1.45868	1.46488	(34)
C ₁₃ H ₂₀ O ₈	Tetraethyl methanetetracarboxylate....	13.5	1.1401	1.43375	1.43593	1.44162	1.44633	(35)
C ₁₃ H ₂₂ O ₂	Ethoxymethylenementhone.....	15.15	0.9696	1.48587	1.48945	1.49954	1.50907	(17)
C ₁₃ H ₂₂ O ₂	Ethyl α -(1, 3-dimethyl-cyclohexylidene)-5-propionate.....	18.7	0.9702	1.50227	1.50753	1.52136	1.53443	(84)
C ₁₃ H ₂₂ O ₄	Diethyl <i>cis</i> -hexahydrohomophthalate...	21.1	1.0394	1.45129	1.45363*	1.45913	1.46386	(73)
C ₁₃ H ₂₂ O ₄	Diethyl <i>trans</i> -hexahydrohomophthalate...	21.2	1.0369	1.45039	1.45283*	1.45833	1.46277	(73)
C ₁₃ H ₂₂ O ₄	<i>o</i> -Ethyl allomethylcamphorate.....	17.7	1.0569	1.45809	1.46042		1.47063	(99)
C ₁₃ H ₂₂ O ₄	<i>o</i> -Methyl alloethylcamphorate.....	17.1	1.0492	1.45656	1.45889		1.46905	(99)
C ₁₃ H ₂₃ NO ₄	Diethyl <i>N</i> -methylpyrrolidinediacetate..	15.5	1.0472	1.45723	1.45969	1.46607	1.47148	(25)
C ₁₃ H ₂₄ O ₂	Hexylpropionic acetal.....	12.1	0.8808	1.4398	1.4424	1.4483	1.4530	(150)
C ₁₃ H ₂₆ O ₂	<i>n</i> -Decyl propionate.....	20	0.8639	1.42696	1.42907	1.43434	1.43863	(163)
C ₁₃ H ₂₈ O	Propyl <i>n</i> -decyl ether.....	20	0.7969	1.42273	1.42487	1.43019	1.43444	(163)
C ₁₄ H ₁₂	α -Phenylstyrene.....	20	1.0232	1.60089	1.60849	1.62730	1.64482	(45)
C ₁₄ H ₁₂	9-Methylfluorene.....	66.2	1.0263	1.60233	1.61009	1.63189		(48)
C ₁₄ H ₁₂ O	Diphenylacetaldehyde.....	21.9	1.0986	1.58500	1.59114*	1.60646	1.62043	(28)
C ₁₄ H ₁₄	<i>p</i> -Methyldiphenylmethane.....	19.3	0.9978	1.56579	1.57103	1.58571	1.59804	(48)
C ₁₄ H ₁₄ O	1-Ethyl-4-acetylnaphthalene.....	15.7	1.0922	1.61139	1.61979	1.64374	1.66762	(145)
C ₁₄ H ₁₄ O ₂	Ethyl α -methyl- β -naphthoate.....	22.1	1.1103	1.58638	1.59408*	1.61423	1.63293	(70)
C ₁₄ H ₁₄ O ₃	Ethyl 1-methoxy-2-naphthoate.....	17.7	1.1486	1.58180	1.58923	1.60964	1.62908	(48)
C ₁₄ H ₁₄ O ₃	Ethyl 3-methoxy-2-naphthoate.....	17.7	1.1616	1.59336	1.60090	1.62243	1.64306	(48)
C ₁₄ H ₁₅ N	Dibenzylamine.....	21.6	1.0256	1.56885	1.57432	1.58817	1.60017	(106)
C ₁₄ H ₁₅ NO	β -Acetylethylaminonaphthalene.....	23.1	1.0893	1.59614	1.60312	1.62261	1.64039	(145)
C ₁₄ H ₁₆	1, 4-Diethylnaphthalene.....	13.1	0.9983	1.59005	1.59699	1.61642	1.63423	(145)
C ₁₄ H ₁₆	1, 3-Dimethyl-5-phenyl-3, 5-cyclohexadiene.....	17.0	0.9722	1.56824	1.57486	1.59322	1.61083	(83)
C ₁₄ H ₁₆ N ₂	1-Benzyltetrahydroindazole.....	17.0	1.0923	1.56906	1.57393*	1.58576	1.59629	(60)
C ₁₄ H ₁₆ N ₂	2-Benzyltetrahydroindazole.....	16.1	1.0903	1.57124	1.57620*	1.58836	1.59912	(60)
C ₁₄ H ₁₆ O	Octracene.....	62.4	1.0760	1.56549	1.57072	1.58603		(64)
C ₁₄ H ₁₆ O	1-Ketooctahydrophenanthrene.....	100.1	1.0638	1.55863	1.56282	1.57821		(64)
C ₁₄ H ₁₆ O ₂	Ethyl $\Delta^1\alpha$ -methyl- β -naphthoate.....	15.6	1.0906	1.56723	1.57438*	1.59295	1.61143	(70)
C ₁₄ H ₁₆ O ₂	Ethyl α -methylcinnamylideneacetate....	18.7	1.0421	1.60262	1.61553*	1.65283	1.69588	(27)
C ₁₄ H ₁₆ O ₂	Ethyl β -methylcinnamylideneacetate....	25.1	1.0384	1.58849	1.59936*	1.63013	1.66379	(27)
C ₁₄ H ₁₆ O ₂	Ethyl γ -methylcinnamylideneacetate....	20.3	1.0387	1.59010	1.60100*	1.63176	1.66551	(27)
C ₁₄ H ₁₆ O ₃	1-Ethyl-3, 5-dimethyl-2-acetoxycoumarone.....	20.4	1.0776	1.52527	1.53010	1.54381	1.55630	(23)
C ₁₄ H ₁₆ O ₃	1-Isopropyl-4-methyl-2-acetoxycoumarone.....	19.1	1.0823	1.52377	1.52846	1.54241	1.55466	(23)
C ₁₄ H ₁₆ O ₄	Diethyl benzalmalonate.....	20.4	1.1045	1.53242	1.53894	1.55697	1.57444	(45)
C ₁₄ H ₁₆ O ₄	Ethyl 4-methyl-2-ethoxycoumarilate....	52.6	1.1044	1.53367	1.54037	1.55855	1.57637	(41)
C ₁₄ H ₁₇ N	α -Diethylaminonaphthalene.....	18.1	1.0071	1.58611	1.59331	1.61410	1.63305	(145)
C ₁₄ H ₁₇ N	β -Diethylaminonaphthalene.....	21.6	1.0242	1.62219	1.63210	1.66216	1.69595	(145)
C ₁₄ H ₁₈	Octahydroanthracene.....	88.8	0.9648	1.53230	1.63625	1.54791	1.55788	(64)
C ₁₄ H ₁₈	Octahydrophenanthrene.....	12.8	1.0313	1.56588	1.57006	1.58189	1.59185	(64)
C ₁₄ H ₁₈	1, 3-Dimethyl-5-phenyl-3-cyclohexene...	15.3	0.9462	1.53131	1.53617	1.54773	1.55799	(83)
C ₁₄ H ₁₈	1-Phenyl-6-methyl-1, 3-heptadiene.....	14.9	0.9486	1.57364	1.58232	1.60620	1.63025	(45)
C ₁₄ H ₁₈ O	Benzal dipropyl ketone.....	23.9	0.9718	1.54116	1.54761	1.56514	1.58203	(8)
C ₁₄ H ₁₈ O ₂	Ethyl <i>p</i> , α , β -trimethylcinnamate.....	18.35	1.0027	1.51483	1.51915	1.53187	1.54290	(14)
C ₁₄ H ₁₈ O ₃	Ethyl α -(β -phenylethyl)-acetoacetate...	24.15	1.0441	1.49260	1.49636*	1.50548	1.51329	(70)
C ₁₄ H ₂₀ O ₄	Methyl acetylcamphorcarboxylate.....	19.8	1.0823	1.48128	1.48439	1.49202	1.49847	(43,† 115)

Formula	Name	<i>t</i> , °C	<i>d</i> ₄ ^{<i>t</i>}	α	D	β	γ	Lit.
C ₁₄ H ₂₀ O ₉	Tetraethyl oxalylmethanetricarboxylate.	15.45	1.1671	1.43820	1.44026	1.44627		(35)
C ₁₄ H ₂₂ O ₂	Butyryleamphor.....	17.35	1.0161	1.48900	1.49233	1.50088	1.50844	(119)
C ₁₄ H ₂₂ O ₂	Ethyl α -(1, 3-dimethyl-3, 5-cyclohexa- diene)-5-isobutyrate.....	13.4	0.9689	1.48605	1.48950	1.49858	1.50654	(84)
C ₁₄ H ₂₂ O ₃	Ethyl ethylisophoronecarboxylate.....	19	1.0109	1.47936	1.48288	1.49148	1.49921	(44)
C ₁₄ H ₂₂ O ₄	Diethyl <i>dl</i> -dehydrocamphorate.....	16.4	1.0399	1.46313	1.46588	1.47287	1.47879	(9)
C ₁₄ H ₂₄ N ₂	Tetraethyl- <i>o</i> -phenylenediamine.....	12.6	0.9267	1.51676	1.52134	1.53467	1.54654	(145)
C ₁₄ H ₂₄ N ₂	Tetraethyl- <i>m</i> -phenylenediamine.....	11.8	0.9522	1.54778	1.55367	1.57051	1.58588	(145)
C ₁₄ H ₂₄ O ₄	Diethyl camphorate.....	26.2	1.0244	1.45127	1.45354	1.45906	1.46347	(97)
C ₁₄ H ₂₄ O ₄	Diethyl <i>d-cis</i> -camphorate.....	19.1	1.0319	1.45386	1.45613	1.46179	1.46649	(80)
C ₁₄ H ₂₄ O ₄	Diethyl <i>l-trans</i> -camphorate.....	21.6	1.0286	1.45226	1.45454	1.46015	1.46506	(80)
C ₁₄ H ₂₄ O ₇	Tetraethyl citrate.....	20	1.1022	1.44582	1.44844	1.45476		(93)
C ₁₄ H ₂₆ O ₂	<i>n</i> -Deeryl butyrate.....	20	0.8617	1.42867	1.43077	1.43613	1.44048	(163)
C ₁₄ H ₂₆ O ₂	Heptyl heptoate.....	18.8	0.86492	1.42692	1.43177	1.43718	1.44155	(125)
C ₁₄ H ₃₀ O	Dimethylundecyl carbinol.....	81.8		1.41520	1.41736*	1.42249	1.42675	(127)
C ₁₄ H ₃₀ O	Butyl decyl ether.....	20	0.8009	1.42565	1.42777	1.43302	1.43735	(163)
C ₁₆ H ₁₂ O ₃	Methyl <i>o</i> -benzoylbenzoate.....	19.65	1.1900	1.58480	1.59128	1.60874	1.62492	(49)
C ₁₆ H ₁₄	<i>m</i> -Methylstilbene.....	60.5	0.9891	1.62501	1.63628	1.66982		(48)
C ₁₆ H ₁₄	α -Phenyl- β -methylstyrene.....	63.5	0.9813	1.57197	1.57913	1.59638	1.61169	(45)
C ₁₆ H ₁₄ O	3-Allyl-2-hydroxydiphenyl.....	18.7	1.0735	1.59411	1.60107*	1.61850	1.63439	(87)
C ₁₆ H ₁₄ O ₆	Diethyl phthalylmalonate.....	84.4	1.1887	1.53416	1.54105	1.56155		(36)
C ₁₆ H ₁₆	1-Phenyl-1- <i>p</i> -tolylethane.....	17.2	0.9847	1.56038	1.56590	1.57962	1.59192	(13)
C ₁₆ H ₁₆ O	3-Propyl-2-hydroxydiphenyl.....	16.0	1.0512	1.57462	1.58063*	1.59606		(87)
C ₁₆ H ₁₆ O	1-Methyl-4-ethyl-2-acetylnaphthalene...	15.1	1.0737	1.60390	1.61183	1.63455	1.65676	(145)
C ₁₆ H ₁₈	1-Methyl-2, 4-diethylnaphthalene.....	13.3	0.9870	1.58549	1.59231	1.61135	1.62870	(145)
C ₁₆ H ₁₈ O	<i>o, o, p</i> -Triallylphenol.....	12.75	0.9801	1.53963	1.54451	1.55776	1.56937	(47)
C ₁₆ H ₁₈ O	<i>o, o</i> -Diallylphenol allyl ether.....	12.75	0.9563	1.52144	1.52583	1.53792	1.54823	(47)
C ₁₆ H ₁₈ O ₂	4, 7-Dimethyl-2, 2-diethylindanedione..	62.4	1.0174	1.52107	1.52598	1.54051		(36)
C ₁₆ H ₁₉ NO ₂	Tropacocaine.....	100.1	1.0426	1.50440	1.50801	1.51840	1.52707	(25)
C ₁₆ H ₂₀ O ₆	Triallyl tricarballylate.....	15.9	1.0973	1.46461	1.46747	1.47463	1.48076	(71)
C ₁₆ H ₂₀ O ₇	Triallyl citrate.....	17.4	1.1358	1.46798	1.47142	1.47839	1.48439	(71)
C ₁₆ H ₂₀ O ₁₀	Tetraethyl dioxalylmalonate.....	14.9	1.1926	1.45378	1.45665	1.46452	1.47138	(35)
C ₁₆ H ₂₂ O ₃	Methyl allylcamphorcarboxylate.....	20.2	1.0670	1.48839	1.49113	1.49783	1.50326	(114)
C ₁₆ H ₁₆ O ₄	Diethyl naphthalate.....	70.0	1.1399	1.55245	1.55863	1.57648	1.59319	(48)
C ₁₆ H ₁₈	2-Phenylcymene.....	15	0.9776	1.56228	1.56797	1.58266	1.59626	(143)
C ₁₆ H ₁₈	2-Phenylmenthatriene.....	15	0.9752	1.56307	1.56914	1.58476	1.59911	(143)
C ₁₆ H ₁₈ O ₂	<i>o, o</i> -Diethoxydiphenyl.....	47.4	1.0430	1.55479	1.56022	1.57603	1.59014	(48)
C ₁₆ H ₂₀ O ₅	Diethyl α -oxalyl- γ -phenylbutyrate.....	15.75	1.1162	1.49164	1.49526	1.50439		(70)
C ₁₆ H ₂₂ O ₄	Ethyl α, α -diethyl(<i>o</i> -methoxybenzoyl) acetate.....	12.3	1.0931	1.51272	1.51742	1.52868	1.53909	(19)
C ₁₆ H ₂₄ O ₆	Diethyl camphoric carbonate.....	19.4	1.0765	1.47417	1.47417	1.48140	1.48729	(43, † 97)
C ₁₆ H ₂₆ ClO ₃	Amyl chlorocamphorcarboxylate.....	19.0	1.0906	1.48391	1.48655	1.49285	1.49800	(116)
C ₁₆ H ₂₆ O	Phenyl <i>n</i> -decyl ether.....	20	0.8981	1.48279	1.48618	1.49474	1.50213	(163)
C ₁₆ H ₂₆ O ₃	Isoamyl camphorcarboxylate.....	17.2	1.0143	1.47343	1.47596	1.48197	1.48685	(113, † 122)
C ₁₆ H ₂₇ N	Diamylaniline.....	24.9	0.8893	1.50368	1.50826		1.53074	(106)
C ₁₇ H ₁₄ Br ₂ O ₂	Ethyl 2, 7-dibromofluorene-9-acetate....	99.8	1.5121	1.60527	1.61300	1.63481	1.65429	(145)
C ₁₇ H ₁₆ O ₂	Ethyl α -phenylcinnamate.....	18 55	1.0971	1.58973	1.59723	1.61959		(45)
C ₁₇ H ₂₀	2-Benzylcymene.....	15	0.9690	1.55138	1.55650	1.56958	1.58098	(143)
C ₁₇ H ₂₁ NO ₄	<i>d-ϕ</i> -Cocaine.....	99.6	1.1020	1.49862	1.50218	1.51199	1.51959	(25)
C ₁₇ H ₂₁ NO ₄	<i>dl-ϕ</i> -Cocaine.....	99.5	1.1026	1.49867	1.50209	1.51193	1.51996	(25)
C ₁₇ H ₃₆	<i>n</i> -Heptadecane.....	79.0		1.41105	1.41320*	1.41832	1.42251	(127)
C ₁₈ H ₁₈ O ₂	Ethyl α -benzylcinnamate.....	16.1	1.0831	1.58163	1.58850	1.60717		(45)
C ₁₈ H ₂₀	1, 4-Diphenyl-1-ethyl-3-butene.....	22.8	0.9892	1.58083	1.58749	1.60490	1.62049	(44)
C ₁₈ H ₂₆ N ₂	1, 4-Diethylaminonaphthalene.....	99.6	0.9318	1.53320	1.53943	1.55827	1.57731	(145)
C ₁₈ H ₂₆ N ₂	1, 5-Diethylaminonaphthalene.....	26.8	0.9889	1.56740	1.57421	1.59428	1.61449	(145)
C ₁₈ H ₂₆ N ₂	1, 8-Diethylaminonaphthalene.....	18.0	1.0124	1.58707	1.59508	1.61916	1.64005	(145)
C ₁₈ H ₂₈ O	Undecyl phenyl ketone.....	52.4	0.900	1.48149	1.48503	1.49425		(8)
C ₁₈ H ₂₈ O ₄	Amyl acetylcamphorcarboxylate.....	20.5	1.0223	1.47426	1.47717	1.48438	1.49049	(43, † 115)
C ₁₈ H ₂₈ O ₄	Ethyl isovalerylcamphorcarboxylate....	22.7	1.0219	1.47366	1.47644	1.48390	1.48995	(43, † 115)
C ₁₉ H ₂₀	<i>meso</i> -Isoamylanthracene.....	71.1	1.0017	1.62491	1.63636	1.67152		(22)
C ₁₉ H ₂₂	Dihydro- <i>meso</i> -isoamylanthracene.....	44.4	0.9940	1.55791	1.56261	1.57651	1.58868	(22)
C ₂₀ H ₂₆ O ₂	2, 3-Diamylhydroxynaphthalene.....	19.5	0.9919	1.54057	1.54621	1.56187		(48)
C ₂₀ H ₂₈ O ₂	2, 7-Diamylhydroxynaphthalene.....	99.6	0.9335	1.51043	1.51547	1.53068		(48)
C ₂₀ H ₂₈ O ₂	1, 5-Dihydroxynaphthalenediamyl ether.	99.9	0.9411	1.51083	1.51602	1.53128		(145)

Formula	Name	t , °C	d_4^t	α	D	β	γ	Lit.
C ₂₀ H ₄₀	Dimethylhexadecylethylene.....	79.1		1.42600	1.42847*	1.43434	1.43931	(127)
C ₂₀ H ₄₀ O ₂	<i>n</i> -Decyl caprate.....	20	0.8586	1.44006	1.44232	1.44783	1.45236	(163)
C ₂₀ H ₄₂ O	Di- <i>n</i> -decyl ether.....	20	0.8187	1.43955	1.44182	1.44743	1.45206	(163)
C ₈ H ₂₀ Sn	Tetraethyl tin.....		1.4089	1.5065	1.5143		1.5403	(132)
C ₈ H ₂₀ Pb	Dimethylethylisobutyl lead.....	20.7	1.6234	1.50327	1.50783	1.51982	1.53010	(136)
C ₈ H ₂₀ Pb	Methyldiethylpropyl lead.....	22.1	1.6403	1.50925	1.51412	1.52638	1.53710	(136)
C ₉ H ₂₂ Pb	Dimethylethylisoamyl lead.....	21.7	1.5579	1.50079	1.50524	1.51662	1.52647	(136)
C ₁₀ H ₂₄ Pb	Dimethylpropylisoamyl lead.....	22	1.5028	1.49773	1.50201	1.51313	1.52251	(136)
C ₁₀ H ₂₄ Pb	Methyldiethylisoamyl lead.....	20.8	1.5225	1.50336	1.50783	1.51921	1.52934	(136)
C ₁₀ H ₂₄ Pb	Tri- <i>n</i> -propylmethyl lead.....	22.3	1.5220	1.50456	1.50911	1.52059	1.53058	(137)
C ₁₁ H ₂₆ Pb	Diethylpropylisobutyl lead.....	20	1.4890	1.50751	1.51195	1.52353	1.53359	(136)
C ₁₁ H ₂₆ Pb	Methylethyl- <i>n</i> -propylisoamyl lead.....	21.0	1.4792	1.50189	1.50636	1.51747	1.52720	(136)
C ₁₁ H ₂₆ Pb	Tri- <i>n</i> -propylethyl lead.....	21.3	1.4846	1.50703	1.51149	1.52290	1.53299	(137)
C ₁₂ H ₂₈ Pb	Diethylpropylisoamyl lead.....	22.1	1.4392	1.50217	1.50655	1.51758	1.52721	(136)
C ₁₃ H ₃₀ Pb	Triisobutylmethyl lead.....	19.6	1.3977	1.49883	1.50321	1.51397	1.52324	(137)
C ₁₃ H ₃₀ Pb	Tri- <i>n</i> -propylisobutyl lead.....	22.6	1.4034	1.50235	1.50673	1.51766	1.52716	(137)
C ₁₄ H ₃₂ Pb	Triisobutylethyl lead.....	22.1	1.3758	1.50134	1.50552	1.51636	1.52573	(137)
C ₁₄ H ₃₂ Pb	Tri- <i>n</i> -propylisoamyl lead.....	21.0	1.3810	1.50049	1.50465	1.51535	1.52462	(137)
C ₁₅ H ₃₄ Pb	Triisobutyl- <i>n</i> -propyl lead.....	19.6	1.3505	1.50148	1.50561	1.51631	1.52554	(137)
C ₁₆ H ₃₆ Pb	Tetraisobutyl lead.....	20.2	1.3240	1.50004	1.50416	1.51461	1.52375	(137)
C ₁₆ H ₃₆ Pb	Triisoamylmethyl lead.....	22	1.3134	1.49226	1.49618	1.50612	1.51477	(137)
C ₁₇ H ₃₈ Pb	Triisoamylethyl lead.....	19.6	1.2922	1.49425	1.49825	1.50818	1.51669	(137)
C ₁₇ H ₃₈ Pb	Triisobutylisoamyl lead.....	20.6	1.2976	1.49696	1.50097	1.51118	1.51989	(137)
C ₁₈ H ₄₀ Pb	Triisoamyl- <i>n</i> -propyl lead.....	22	1.2737	1.49324	1.49703	1.50696	1.51542	(137)
C ₁₉ H ₄₂ Pb	Triisoamylisobutyl lead.....	19.5	1.2522	1.49242	1.49618	1.50597	1.51428	(137)
C ₂₀ H ₄₄ Pb	Tetraisoamyl lead.....	20.5	1.2332	1.49075	1.49457	1.50404	1.51232	(137)

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Anschütz and Brocker, *25*, **59**: 2844; 26. (2) Arhuzov and Ivanov, *53*, **47**: 2019; 2025; 15. (3) Auwers, *25*, **44**: 588; 11. (4) Auwers, *25*, **44**: 788; 11. (5) Auwers, *25*, **44**: 3514; 11. (6) Auwers, *25*, **44**: 3525; 11. (7) Auwers, *25*, **44**: 3679; 11. (8) Auwers, *25*, **45**: 2764; 12. (9) Auwers, *25*, **46**: 494; 13. (10) Auwers, *25*, **46**: 2988; 13. (11) Auwers, *25*, **47**: 2334; 14. (12) Auwers, *25*, **47**: 3292; 14. (13) Auwers, *25*, **49**: 2389; 16. (14) Auwers, *13*, **413**: 253; 17. (15) Auwers, *25*, **50**: 1177; 17. (16) Auwers, *13*, **415**: 98; 18. (17) Auwers, *13*, **415**: 169; 18. (18) Auwers, *25*, **51**: 1116; 18. (19) Auwers, *25*, **52**: 113; 19. (20) Auwers, *13*, **419**: 92; 19. (21) Auwers, *13*, **420**: 84; 20. (22) Auwers, *25*, **53**: 941; 20. (23) Auwers, *13*, **422**: 133; 21. (24) Auwers, *25*, **54**: 987; 21. (25) Auwers, *52*, **105**: 102; 22. (26) Auwers, *13*, **432**: 84; 23. 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REFRACTIVITY OF MIXTURES

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Every substance appearing in this section is entered in Table 1 in its proper place, as determined by its formula, in standard (resp. \mathfrak{C} -) arrangement. It appears as a B-component in the section devoted to aqueous solutions, or as an A-component in other sections. At that place reference by serial number is given to each other place at which it occurs. Each system in the dispersion table (Table 5) has the same serial number as in Table 1 or 2.

In most cases observers have aimed at relative, and not absolute accuracy, hence such a tabulation as that here given subjects the data to a purpose never intended by the observer. A number of gross errors have been detected; some seem to be certainly errors in transcription and some of these have been corrected; the source of others cannot be determined. A number of such errors, one as great as 0.1% of n , occur in the data of Krollpfeiffer (76); he seems to have much over-estimated the accuracy of his data.

Eine jede in diesem Teil enthaltene Substanz befindet sich in Tafel 1 an der Stelle, welche ihr durch die Formel in der Standard- (bezw. \mathfrak{C} -) Anordnung zukommt. Die Substanz ist entweder als B-Komponente in dem Abschnitt der wässrigen Lösungen enthalten, oder sie befindet sich als A-Komponente in den anderen Abschnitten. An dieser Stelle wird durch eine Serienzahl der Hinweis, zu jeder anderen Stelle gegeben, wo sie vorhanden ist. Jedes System in der Dispersions-Tafel 5 hat dieselbe Serienzahl wie in der Tafel 1 oder 2.

In vielen Fällen haben die Beobachter eine relative statt eine absolute Genauigkeit angestrebt. Daher werft ein Tafel, wie der hier zusammengestellte, die Daten einem Zwecke unter, der von dem Beobachter nie beabsichtigt war. Eine Anzahl grober Fehler sind aufgefunden worden. Einige davon sind sicher Übertragungsfehler und einige davon sind korrigiert; die Quelle anderer konnte nicht aufgefunden werden. Solche Fehler bis 0,1% in n kommen in den Daten von Krollpfeiffer (76) vor, es scheint als ob dieser Autor die Genauigkeit seiner Zahlen sehr überschätzt hätte.

Chaque substance mentionnée dans cette section est située dans la Table 1 à sa propre place, ainsi qu'elle est déterminée par sa formule dans l'arrangement type (resp. arrangement \mathfrak{C}). Elle est considérée comme un constituant B dans la section se rapportant aux solutions aqueuses, ou comme un constituant A dans les autres sections. À cette place il est donné une référence par un nombre de série se rapportant à chaque autre place à laquelle la substance se présente. Dans la table de dispersion (Table 5) chaque système a le même nombre de série que dans la Table 1 ou 2.

Dans la plupart des cas, les expérimentateurs ont eu pour but d'obtenir une précision relative et non absolue, par conséquent un arrangement en tableaux tel qu'il est donné ici, soumet les données à un but qui n'a jamais été visé par l'expérimentateur. Un certain nombre d'erreurs grossières a été décelé; quelques unes paraissent être certainement des erreurs de transcriptions et certaines de celles-ci ont été corrigées; la source des autres n'a pu être déterminée. Un certain nombre de telles erreurs, dont l'une atteint 0,1% de n , se trouve dans les données de Krollpfeiffer (76); cet auteur semble avoir beaucoup surestimé la précision de ses données.

Le sostanze comprese in questo capitolo sono situate nella Tabella 1 al posto che ad esse spetta, secondo la formula scritta col sistema tipo (o col sistema \mathfrak{C}). Esse figurano come componente B nella sezione dedicata alle soluzioni acquose o come componente A nelle altre sezioni. In quel posto è indicato a mezzo del numero di serie quali sono gli altri posti dove ciascuna sostanza è nominata. Ogni sistema ha nella Tabella 5 lo stesso numero di serie che nella Tabella 1 o 2.

Nel maggior numero dei casi gli osservatori si sono prefissi di raggiungere un'accuratezza relativa e non già assoluta; l'ordinamento dei dati nella maniera qui adoperata li fa servire perciò ad uno scopo non previsto dagli sperimentatori. Sono stati rilevati parecchi errori notevoli, alcuni sembra che debbono essere certamente attribuiti alla trascrizione, e sono stati corretti. L'origine degli altri non si è potuta stabilire. Parecchi di tali errori—uno arriva fino al 0,1% di n —si trovano fra i valori di Krollpfeiffer (76); sembra che questi abbia apprezzato molto al di là del giusto l'accuratezza dei suoi valori.

SYMBOLS

a, b, c	Coefficients in $n = a + b(10)^{-3} (\% \text{ B}) + c(10)^{-6} (\% \text{ B})^2$.
g B/kg A	Number of grams of B per 1000 grams of A in a binary mixture.
M_A/M_B	Molecular dilution of B = number of moles of A per mole of B in a binary mixture.
$d_{t'}''$	Specific gravity at $t''^\circ\text{C}$ with reference to water at $t'^\circ\text{C}$.
eq.	Equilibrium.
Isom.	Isomer.
k	$n = n_0 + k(\text{g B/l soln.})(10)^{-4}$.
max.	Maximum value of.
$M_B/\text{l soln.}$	Number of gram moles of B per liter of mixture.
n	Index of refraction.
n_λ^t	Index of refraction at $t^\circ\text{C}$, for light of wave-length λ .
N	Number of gram-equivalents of B per liter of mixture.
$\% \text{ B}$	Number of grams of B per 100 grams of mixture = Wt. $\%$ of B.
V_A	Unit volumes of constituent A.
Vol. $\% \text{ B}, t^\circ$	Volume of pure B, at $t^\circ\text{C}$, per 100 cm^3 of mixture, at $t^\circ\text{C}$ = Vol. $\%$ of B.
g B/l soln.	Number of grams of B per liter of mixture.
α	$dn/dt = -\alpha \times 10^{-4}$.
δ_d	$1000d_d^t = 1000 + \delta_d$.
δ_n	$1000n_D^t = 1333 + \delta_n$.
ϵ	Accuracy of n is $\pm 0.0001\epsilon$.
λ	Wave-length of light.
(λ_2^1)	$(n_{\lambda_2} - n_{\lambda_1}) = (\lambda_2^1) \times 10^{-5}$. The λ 's may be indicated by the Fraunhofer letter notation.
#	Indicates a place for which no digit is given; e.g., 5# indicates that the value is nearer 50 than 40 or 60, but the second digit is not known.

SYMBOLE

a, b, c,	Koeffizient von $n = a + b(10)^{-3} (\% \text{ B}) + c(10)^{-6} (\% \text{ B})^2$.
g B/kg A	Anzahl von Gramm des Stoffes B auf 1000 g von A in einer binären Mischung.
M_A/M_B	Molekulare Verdünnung von B = Zahl der Mole von A auf Mole von B in der binären Mischung.
$d_{t'}''$	Spezifisches Gewicht bei $t''^\circ\text{C}$ auf Wasser bei $t'^\circ\text{C}$ bezogen.
eq.	Gleichgewicht.
Isom.	Isomer.
k	$n = n_0 + k(\text{g B/l soln.})(10)^{-4}$.
max.	Maximaler Wert von.
$M_B/\text{l soln.}$	Zahl der Gramm-Mole von B pro Liter der Mischung.
n	Brechungsindex.
n_λ^t	Brechungsindex bei $t^\circ\text{C}$, für Licht von der Wellenlänge λ .
N	Zahl der Gramm-Äquivalente von B pro Liter der Mischung.
$\% \text{ B}$	Zahl der Gramme von B pro 100 g der Mischung = Gewichts $\%$ von B.
V_A	Einheitsvolumen des Bestandteiles A.
Vol. $\% \text{ B}, t^\circ$	Volumen des reinen B bei $t^\circ\text{C}$ pro 100 cm^3 der Mischung bei $t^\circ\text{C}$ = Vol. $\%$ von B.
g B/l soln.	Zahl der Gramme von B pro Liter der Mischung.
α	$dn/dt = -\alpha \times 10^{-4}$.

SYMBOLES

a, b, c	Coefficients dans $n = a + b(10)^{-3} (\% \text{ B}) + c(10)^{-6} (\% \text{ B})^2$.
g B/kg A	Nombre de grammes de B pour 1000 grammes de A dans le mélange binaire.
M_A/M_B	Dilution moléculaire de B = nombre de molécules de A pour une molécule de B dans le mélange binaire.
$d_{t'}''$	Poids spécifique à $t''^\circ\text{C}$ par rapport à de l'eau à $t'^\circ\text{C}$.
eq.	Équilibre.
Isom.	Isomère.
k	$n = n_0 + k(\text{g B/l soln.})(10)^{-4}$.
max.	Valeur maximum de.
$M_B/\text{l soln.}$	Nombre de Mol. gr. de B par litre de mélange.
n	Indice de réfraction.
n_λ^t	Indice de réfraction à $t^\circ\text{C}$ pour une lumière de longueur d'onde λ .
N	Nombre d'équivalents grammes de B par litre de mélange.
$\% \text{ B}$	Nombre de grammes de B pour 100 grammes de mélange = $\%$ poids de B.
V_A	Volumes unités du constituant A.
Vol. $\% \text{ B}, t^\circ$	Volume de B pur à $t^\circ\text{C}$ pour 100 cm^3 de mélange à $t^\circ\text{C}$ = $\%$ Vol. de B.
g B/l soln.	Nombre de grammes de B par litre de mélange.
α	$dn/dt = -\alpha \times 10^{-4}$.
δ_d	$1000d_d^t = 1000 + \delta_d$.
δ_n	$1000n_D^t = 1333 + \delta_n$.
ϵ	La précision de n est $\pm 0,0001\epsilon$.
λ	Longueur d'onde de la lumière.
(λ_2^1)	$(n_{\lambda_2} - n_{\lambda_1}) = (\lambda_2^1) \times 10^{-5}$. Les λ peuvent être indiquées par les lettres de la notation de Fraunhofer.
#	Indique une place pour laquelle aucun chiffre n'est donné; par ex., 5# indique que la valeur est plus rapprochée de 50 que de 40 ou de 60, mais que le second chiffre n'est pas connu.

SIMBOLI

a, b, c,	Coefficienti in $n = a + b(10)^{-3} (\% \text{ B}) + c(10)^{-6} (\% \text{ B})^2$.
g B/kg A	Numeri di grammi di B per 1000 grammi di A in una miscela binaria.
M_A/M_B	Diluizione molecolare di B = numero di molecole di A per molecole di B in una miscela binaria.
$d_{t'}''$	Peso specifico a $t''^\circ\text{C}$ rispetto all'acqua a $t'^\circ\text{C}$.
eq.	Equilibrio.
Isom.	Isomero.
k	$n = n_0 + k(\text{g B/l soln.})(10)^{-4}$.
max.	Massimo valore di.
$M_B/\text{l soln.}$	Numero di grammi molecole di B per litro di miscela.
n	Indice di rifrazione.
n_λ^t	Indice di rifrazione a $t^\circ\text{C}$, per luce di lunghezza d'onda λ .
N	Numero di grammi equivalenti di B per litro di miscela.
$\% \text{ B}$	Numero di grammi di B per 100 grammi di miscela = peso $\%$ di B.
V_A	Volumi unitari del costituente A.
Vol. $\% \text{ B}, t^\circ$	Volume di B puro a $t^\circ\text{C}$, per 100 cm^3 di miscela a $t^\circ\text{C}$ = Vol. $\%$ di B.

δ_d	$1000d_4^t = 1000 + \delta_d$.
δ_n	$1000n_D^t = 1333 + \delta_n$.
ϵ	Genauigkeit von n ist $\pm 0,0001\epsilon$.
λ	Wellenlänge des Lichtes.
(λ_1) (λ_2)	$n_{\lambda_2} - n_{\lambda_1} = (\lambda_1) \times 10^{-5}$. Die λ -Werte können nach der Bezeichnungsweise von Fraunhofer gekennzeichnet werden.
#	Zeigt eine Stelle an, für welche keine Ziffer vorliegt; z. B. 5# gibt an, dass der Wert näher an 50 als an 40 oder 60 liegt, aber die zweite Ziffer ist nicht bekannt.

g B/l soln.	Numero di grammi di B per litro di miscela.
α	$dn/dt = -\alpha \times 10^{-4}$.
δ_d	$1000d_4^t = 1000 + \delta_d$.
δ_n	$1000n_D^t = 1333 + \delta_n$.
ϵ	La precisione di n è $\pm 0,0001\epsilon$.
λ	Lunghezza d'onda della luce.
(λ_1) (λ_2)	$(n_{\lambda_2} - n_{\lambda_1}) = (\lambda_1) \times 10^{-5}$. I λ possono essere indicati con la notazione di Fraunhofer, in lettere.
#	Indica un posto per il quale nessuna cifra viene data; per es., 5# indica che il valore è più vicino a 50 che a 40 o 60, ma la seconda cifra non si conosce

Arithmetical Relations.—For many binary mixtures, n is an additive function of the volume composition of the mixture: $100(n/d)_m = [n_1(\%)_1/d_1] + [n_2(\%)_2/d_2]$ where the subscript m indicates that the quantity refers to the mixture, but if there is a change in volume this relation does not hold. If $100/d_v = [(\%)_1/d_1] + [(\%)_2/d_2]$, $100/n_v = [(\%)_1/n_1] + [(\%)_2/n_2]$, $C_v = (d_m - d_v)/d_m$, and $C_n = (n_m - n_v)/n_m$, where d_m and n_m are the observed values of d and n for the mixture, then $A \equiv C_v/C_n$ has been called the "refraction constant" (133) of the mixture. It varies but slightly with temperature and wave-length. The equation $(d_m - d_v)/d_m = A(n_m - n_v)/n_m$ is called Pulfrich's formula. Levi (81) used the formula $(d_m - d_v)/d_m = A'(n_m - N_v)/(n_m - 1)$, where $100(N_v - 1)/d_v = [(\%)_1(n - 1)/d_1] + [(\%)_2(n - 1)/d_2]$, and Doroszewski (37) has shown that for aqueous solutions of nicotine ($C_{10}H_{14}N_2$) and of trimethyl carbinol ($C_4H_{10}O$) A' is independent of the concentration. Hubbard (70) showed that for a number of mixtures Pulfrich's formula with n replaced by $(n^2 - 1)/(n^2 + 2)$ gives a value of A which is independent of the concentration.

Wave-lengths of the Spectral Lines Used in This Section

In column (2) is the symbol of the chemical element which is the source of the line; in (3) is the Greek letter, and in (4) is the Fraunhofer designation of the line. Unit of $\lambda = 1 \text{ \AA} = 10^{-8} \text{ cm}$.

λ	(2)	(3)	(4)	λ	(2)	(3)	(4)
2314				4679			
2574				4861	H	β	F
2749				4961	Hg	(Blue)	
2981				5351	Tl	(Green)	
3256				5780*	Hg		
3405				5790	Hg	(Yellow)	
3612				5876	He		
4047	Hg			5893*	Na		D
4341	H	γ	G'	6563	H	α	C
4358	Hg	(Violet)		6708	Li	(Red)	

* Mean value of the doublet.

TABLE 1.—REFRACTIVITY AT ONE WAVE-LENGTH: BINARY MIXTURES

Also formula index for all substances covered by this report.

For dispersion and refraction at other wave-lengths, see Table 5. Substances of unknown composition are given at the end of Sections I and IIb.

The index of refraction (n_λ^t) is here tabulated for one or another of the following values of λ : 6563 \AA (C, H α), 5893 (D), 5876 (He), 5790 (Hg), 4861 (F, H β), 3256. (Pulfrich), (Abbe-Zeiss) . . . indicate type of refractometer used; (Kahlbaum) = material obtained from Kahlbaum. E = equivalent weight of B, $n = a + b(\% \text{ B})(10)^{-3} + c(\% \text{ B})^2(10)^{-6} \pm 0.0001\epsilon$, $n = n_0 + k(g \text{ B/l soln.})(10)^{-4} \pm 0.0001\epsilon$. For a given mixture the value of N_B and of $g \text{ B/l soln.}$ varies with the temperature. Unit of $\lambda = 1 \text{ \AA} = 10^{-8} \text{ cm}$. t = centigrade temperature, $^\circ\text{C}$.

Two-Component Systems

Standard Arrangement, v. Vol. III, p. viii; A = H₂O

The refraction of the H₂O used in making the solution is not on record unless it is given below, or the authority is (38, 65, 85, 86); the values given by the latter are: $n_D^{15} = 1.33345$ (38), $n_{3256}^{18} = 1.35326$ (65), $n_D^{70} = 1.32522$ (85), $n_D^{18} = 1.33322$ (86).

A-B-Table

1. HCl			5. HIO ₃ (64); see also 535, 536*		
g B/kg A	n_D^{25}	n_D^{30}	N_{18}	n_D^{18}	
(41)*			0.1	1.33568	
8.02	1.33432	1.33389	0.2	1.33802	
17.72	1.33651	1.33608	0.5	1.34498	
26.81	1.33847	1.33802	1.0	1.35642	
36.92	1.34060	1.34019	2.0	1.37910	
46.07	1.34255	1.34210	4.0	1.42393	
54.79	1.34433	1.34393	* If $N_{21} = 0.5$, $n_D^{21} = 1.3444$ (28); if $g \text{ B/l soln.}$, $25^\circ = 4.4867$, $n_D^{25} = 1.33311$, $d_4^{25} = 1.00093$ (113).		
65.90	1.34662	1.34613	6. HIO ₄ (28); see also 537-539		
73.81	1.34816	1.34769	N_{26}	n_D^{26}	
84.67	1.35025	1.34977	0.5	1.3445	
93.49	1.35190	1.35144	6.1. S; see 229 (5, 42, 85)		
103.3	1.35374	1.35325	7. H ₂ SO ₄ (95 to 96% H ₂ SO ₄): electrically heated SiO ₂ prism; n corrected to air at 20°C and 1 atm. (15); see also Table 5		
114.6	1.35590	1.35534	t	n_D^t	
148.6	1.36187	1.36130	28.4	1.4245	
160.3	1.36395	1.36336	49.1	1.4198	
N_{18} (64)		n_D^{18}	85.8	1.4119	
0.5		1.33753	113.8	1.4058	
1.0		1.34168	173.9	1.3924	
2.0		1.34977	206.8	1.3848	
4.0		1.36480	264.2	1.3709	
* Dipping refractometer; C. P. HCl + dist. H ₂ O; $g \text{ B/kg A}$ checked by Ba(OH) ₂ standardized by HCl checked against Ag (41).			307.5	1.3591	
2. HClO ₃ (64)			7.1. Se; see 229		
N_{18}	n_D^{18}		8. H ₂ SeO ₃ and H ₂ SeO ₄ ; ϵ about 5; $t = 20^\circ\text{C}$ (146); $\lambda = 5893$ (D); see also 540		
0.5	1.33773		% B	H ₂ SeO ₃	H ₂ SeO ₄
1.0	1.34211		2	1.3350	1.3352
2.0	1.35078		4	1.3371	1.3377
3.0	1.35927		6	1.3394	1.3401
3. HBr (64)			8	1.3417	1.3425
0.1	1.33452		10	1.3441	1.3450
0.2	1.33579		12	1.3467	1.3476
0.5	1.33952		14	1.3492	1.3501
1.0	1.34571		16	1.3517	1.3527
2.0	1.35805		18	1.3543	1.3555
4.0	1.38271				
3.1. I (22)					
4. HI (64)					
0.1	1.33525				
0.2	1.33734				
0.5	1.34346				
1.0	1.35387				
2.0	1.37497				

8.—(Continued)

% B	H ₂ SeO ₃	H ₂ SeO ₄
20	1.3570	1.3583
22	1.3598	1.3611
24	1.3628	1.3639
26	1.3658	1.3669
28	1.3689	1.3699
30	1.3721	1.3730
32	1.3755	1.3762
34	1.3789	1.3794
36	1.3823	1.3826
38	1.3858	1.3858
40	1.3895	1.3892
42	1.3935	1.3926
44	1.3977	1.3960
46	1.4020	1.3996
48	1.4064	1.4032
50	1.4109	1.4068
52	1.4156	1.4106
54	1.4205	1.4146
56	1.4255	1.4188
58	1.4305	1.4232
60	1.4358	1.4278
62	1.4414	1.4325
64	1.4474	1.4373
66	1.4537	1.4423
68	1.4603	1.4475
70	1.4670	1.4529
72	1.4741	1.4584
74	1.4816	1.4640
76	1.4893	1.4696
78	1.4971	1.4753
80		1.4810
82		1.4879
84		1.4935
86		1.4989
88		1.5038
90		1.5085
91		1.5106
92		1.5124
93		1.5140
94		1.5153
95		1.5163
96		1.5169
97		1.5171
98		1.5172
99		1.5160

9. NH₄OH (28); see also 537, 540, 543, 544, and (50)

N _t	n _D ^t	t
0.5	1.3326	25
2.0	1.3352	15

10. HNO₃ (94); see also 541, 542

d ₄ ²⁰	n _D ²⁰
1.0209	1.3385
1.0253	1.3394
1.0373	1.3423

11. NH₄F (64)

N ₁₈	n _D ¹⁸
0.1	1.33385
0.2	1.33441
0.5	1.33599
1.0	1.33836
2.0	1.34246
4.0	1.34882

12. NH₄Cl (14, 56)

N ₂₀	n _D ²⁰
1.0	1.34311*
0.1	1.3341
1.0	1.3438
1.0	1.3429 (30°)

* Salt dried at 100°C (56).

13. (NH₄)₂SO₄ (35); best commercial material; see also 545, 546

M _B /M _A	n _D ^t	d ₄ ^t	t
11.06	1.39275	1.2267	16
11.24	1.39246*	1.2259	17

* If g B/l soln., 25° = 26.440, n_D²⁵ = 1.33679, d₄²⁵ = 1.01244 (113).14. NH₄NO₃

N ₂₀ (56)	n _D ²⁰
0.5	1.33776
1.0	1.34251
% B, 25° (95)	n _D ²⁵
10.49	1.3455
12.10	1.3458
20.59	1.3582
27.55	1.3680
49.38	1.3999
62.03	1.4185

15. P₂O₅ (113); see also 547

g B/l soln., 25°	n _D ²⁵	d ₄ ²⁵
3.2267	1.33341	1.00079

16. H₃PO₃ (28); see also 543, 548

M _B /l soln., t°	n _D ^t	t
2.0	1.3507	12*
2.0	1.3479	17.5

* t = 12 to 12.5°C.

16.1. H₃PO₄; see 54917. H₄P₂O₇ (28); see also 550

0.5	1.3435	15
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18. As₂O₃ (2)

g B/l soln.	n _D ²²	d ₂₅ ²⁵
1.796	1.33309	1.0014
3.212	1.33326	1.0025
5.060	1.33348	1.0039
5.670	1.33355	1.0044
6.425	1.33363	1.0050
7.436	1.33381	
10.13	1.33417	1.0080
12.85	1.33450	1.0102
14.368	1.33469	1.0113

g B/l soln. = 1288.39d — 1288.36.

g B/l soln. = 7550n — 10062.7.

α = 0.97 if 20° < t < 27°.

19. As₂O₅ (113); see also 551

g B/l soln., 25°	n _D ²⁵	d ₄ ²⁵
12.7597	1.33444	1.00845

19.1. As₂S₃; see (83)19.2. Sb₂S₃; see (83)

C-Table; The C-Arrangement

A-B-Table continued on p. 70

20. CH₂O, Formaldehyde (107)

% B	n _D ^t
t = 15°C	
0	1.3334
1	1.3345
2	1.3358
3	1.3369
4	1.3382
5	1.3394
6	1.3406
7	1.3418
8	1.3430
9	1.3442
10	1.3454
11	1.3467
12	1.3478
13	1.3489
14	1.3501
15	1.3513
16	1.3525
17	1.3538
18	1.3549
19	1.3560
20	1.3572
21	1.3583
22	1.3597
23	1.3608
24	1.3619
25	1.3629
26	1.3640
27	1.3651

If 0 < % B < 10, b = 1.2, e = 0, ε = 1 or 2.

If 10 < % B < 27, b = 1.215, e = -1.4, ε = 1 or 2.

21. NH₄CNS (64)

N_{18}	n_D^{18}		
0.1	1.33506		
0.2	1.33686		
0.5	1.34222		
1.0	1.35121		
2.0	1.36894		
4.0	1.40406		
M_B/M_A^*	n_D^t	d_4^t	t
4.71	1.45521	1.1114	15
6.28	1.43617	1.0944	15
12.32	1.39634	1.0585	16

* Crystallized from 96 % C₂H₅OH (35).22. CH₄O, Methyl alcohol; see also 254-302

% B	n _D ^t
t = 15°C (38)	
0	1.33339
2	1.33384
5	1.33453
7	1.33504
10	1.33584
12	1.33644
15	1.33730
20	1.33879

22.—(Continued)

% B	n _D ^t
t = 15°C.—(Cont'd)	
25	1.34022
30	1.34138
35	1.34235
40	1.34308
45	1.34359
50	1.34378
55	1.34365
60	1.34327
65	1.34272
70	1.34179
75	1.34067
80	1.33925
85	1.33749
90	1.33545
95	1.33309
100	1.33057

Max. n_D¹⁵ = 1.34380 at % B = 51.

t = 15.5°C, Zeiss (67)

0.00*	1.33336
15.10	1.33728
18.18	1.33820
20.25	1.33888
22.86	1.33987
26.23	1.34090
30.77	1.34184
37.21	1.34279
47.06	1.34358
54.24	1.34369
64.00	1.34294
70.33	1.34184
78.05	1.34002
87.67	1.33663
100.00†	1.33057

t = 17°C (39)

0.0	1.3335
5.7	1.3346
11.0	1.3358
15.0	1.3371
19.5	1.3386
26.0	1.3401
31.4	1.3415
35.0	1.3422
39.7	1.3430
45.2	1.3434
46.8	1.3435
51.1	1.3436
56.0	1.3434
60.5	1.3429
65.2	1.3424
69.8	1.3417
74.6	1.3404
78.4	1.3394
80.1	1.3389
84.8	1.3372
89.9	1.3350
94.6	1.3327
100.0	1.3304

Max. n_D¹⁷ = 1.3436 at % B = 51.1.

22.—(Continued)

% B	n_D^t
$t = 25^\circ\text{C}$ (51)	
0.00	1.33232
21.70	1.33823
37.66	1.34090
52.22	1.34163
54.23	1.34163
64.35	1.34065
68.20	1.33984
80.44	1.33663
86.27	1.33505
92.48	1.33193
100.00	1.32773

Max. $n_D^{25} = 1.34170$ at %

B = 53.

* $d_4^{15.5} = 0.99904$.

† $d_4^{15.5} = 0.7956$.

23. $\text{C}_2\text{HCl}_3\text{O}_2$, Trichloroacetic acid (155)

% B*	n_D^t	d_4^t	t
10.1570	1.34616	1.05090	19.9
17.1480	1.35577	1.08931	19.7
27.2570	1.37006	1.14742	19.8
41.9490	1.38968	1.23408	20.2
57.8790	1.41300	1.34088	19.7

* Unit not stated, probably wt. %.

24. $\text{C}_2\text{H}_2\text{O}_4$, Oxalic acid (113)

g B/l soln., 25°	n_D^{25}	d_4^{25}
3.1407	1.33289	0.99866

25. $\text{C}_2\text{H}_4\text{O}_2$, Acetic acid (41); see also 310–315

g B/kg A	n_D^{25}	n_D^{30}
0.00	1.33251	1.33204
25.37	1.33427	1.33366
47.42	1.33569	1.33509
71.75	1.33720	1.33657
92.93	1.33848	1.33779
120.41	1.34001	1.33926
152.45	1.34172	1.34092
179.87	1.34308	1.34223
220.39	1.34493	1.34405
239.65	1.34579	1.34490
266.89	1.34694	1.34598
303.94	1.34838	1.34740
333.44	1.34949	1.34847
367.90	1.35068	1.34964
405.32	1.35187	1.35077
407.12	1.35226	1.35115
g B/l soln., 25°	n_D^{25} (113)	d_4^{25}
183.753	1.35110	1.03235

26. $\text{C}_2\text{H}_4\text{O}_3$, Glycolic acid (113)

% B	n_D^t
40.4302	1.33632
	1.01006

27. $\text{C}_2\text{H}_5\text{BrO}$, Ethylenebromohydrin; $t = 20^\circ\text{C}$ (106)

% B	n_D^t
0.000	1.3330
3.361	1.3358
10.010	1.3422
18.810	1.3517
22.441	1.3561
30.999	1.3667
40.372	1.3790

27.—(Continued)

% B	n_D^t
49.179	1.3915
53.620	1.3980
60.586	1.4095
72.201	1.4299
80.007	1.4454
90.032	1.4671
95.340	1.4801
100.000	1.4915

28. $\text{C}_2\text{H}_6\text{O}$, Ethyl alcohol; see also 320–348

$t = 15^\circ\text{C}$ (38)

% B	n_D^t
0	1.33345
10	1.34020
20	1.34778
30	1.35470
40	1.35948
46	1.36170
50	1.36290
55	1.36405
60	1.36505
65	1.36586
70	1.36645
75	1.36676
80	1.36690
85	1.36678
90	1.36626
95	1.36518
100	1.36332

Max. $n_D^{15} = 1.36690$ at %
B = 80.

$t = 15.5^\circ\text{C}$, Zeiss (66)

% B	$n_D^{15.5}$
0.00	1.33336
6.00	1.33721
11.33	1.34105
17.56	1.34581
20.35	1.34787
22.11	1.34919
24.21	1.35075
26.06	1.35162
26.80	1.35250
29.87	1.35443
33.82	1.35654
38.98	1.35883
46.00	1.36152
56.09	1.36408
59.35	1.36471
63.01	1.36535
68.32	1.36591
72.50	1.36630
83.63	1.36651
91.09	1.36574
100.00	1.36316

$t = 17.5^\circ\text{C}$ (139)

% B	n_D^t
0.00	1.33320
0.99	1.33367
1.80	1.33416
2.60	1.33466
3.41	1.33517
4.22	1.33568
8.32	1.33843
16.25	1.34441
26.31	1.35043
35.67	1.35565

28.—(Continued)

% B	n_D^t
$t = 17.5^\circ\text{C}$, —(Cont'd)	
45.27	1.35953
55.42	1.36248
66.05	1.36448
77.21	1.36565
83.75	1.36587
88.46	1.36565
95.04	1.36448
100.00	1.36229

Max. $n_D^{17.5} = 1.36587$ at %
B = 83.75.

$t = 18^\circ\text{C}$ (93)

% B	n_D^t
0.00	1.3331
18.5	1.3451
41.2	1.3589
60.8	1.3633
74.0	1.3650
91.9	1.3635
100.00	1.3599

$t = 20^\circ\text{C}$ (12)

Vol. % B, t°	n_D^t	$d_{15.5}^{15.5}$
2.85	1.3333	0.9958
3.56	1.3335	0.9948
4.95	1.3341	0.9929
10.08	1.3370	0.9865
20.08	1.3432	0.9759
29.83	1.3492	0.9656
40.00	1.3545	0.9518
50.15	1.3585	0.9340
60.10	1.3615	0.9132
69.99	1.3633	0.8899
80.00	1.3648	0.8637
84.82	1.3650	0.8499
90.01	1.3643	0.8337
94.97	1.3635	0.8160
99.50	1.3618	0.7961

$t = 25^\circ\text{C}$ (hydrogen scale) (3);
cf. (77); claims $\epsilon = 0.1$, probably $\epsilon > 0.1$; Zeiss; n against air; for the $\text{C}_2\text{H}_6\text{O}$ used, $d_4^{25} = 0.78510 \pm 0.00001$

% B	n_D^t
70	1.363038
74	1.363208
75	1.363239
76	1.363265
77	1.363286
78	1.363302
79	1.363313
79.3	1.363315
80	1.36331
81	1.36326
82	1.36319
83	1.36312
84	1.36305
85	1.36297
86	1.36290
87	1.36280
88	1.36269
89	1.36255
90	1.36239
91	1.36221

28.—(Continued)

% B	n_D^t
92	1.36200
93	1.36178
94	1.36153
95	1.36125
96	1.36094
97	1.36061
98	1.36024
99	1.35984
100	1.35941

Max. $n_D^{25} = 1.363315$ at %
B = 79.3.

(41)

% B	n_D^{25}	n_D^{30}
0.00	1.33251	1.33204
2.43	1.33402	1.33351
3.96	1.33498	1.33444
5.62	1.33604	1.33550
7.66	1.33739	1.33679
9.48	1.33864	1.33807
11.45	1.34001	1.33934
13.93	1.34181	1.34111
15.34	1.34278	1.34204
17.43	1.34428	1.34342
19.44	1.34566	1.34476
21.56	1.34709	1.34609
23.16	1.34818	1.34718
25.45	1.34961	1.34847
27.72	1.35086	1.34974
28.43	1.35123	1.35000

(113)

% B	n_D^{25}
0.0	1.3331
18.5	1.3451
41.2	1.3589
60.8	1.3633
74.0	1.3650
91.9	1.3605
100.0	1.3599

29. $\text{C}_2\text{H}_6\text{O}_2$, Glycol (112); $n_D^{20} = 1.33298 + 0.00009600$ (g B/l soln.)

30. $\text{NH}_4\text{CH}_3\text{CO}_2$, Acetate (47)

$N_{19.5}$	$n_D^{19.5}$	$d_{19.5}^{19.5}$
$\frac{1}{16}$	1.3338	1.0007
$\frac{1}{8}$	1.3343	1.0015
$\frac{1}{4}$	1.3354	1.0036
$\frac{1}{2}$	1.3376	1.0070
1	1.3416	1.0142
2	1.3504	1.0276
4	1.3670	1.0523
N_{18} (64)	n_D^{18}	
0.5	1.33883	
1.0	1.34423	
2.0	1.35470	
4.0	1.37435	

31. $(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$, Oxalate; $t = 18^\circ\text{C}$ (47)

N_{18}	n_D^{18}	d_4^{18}
$\frac{1}{16}$	1.3339	1.0021
$\frac{1}{8}$	1.3345	1.0042
$\frac{1}{4}$	1.3365	1.0084
$\frac{1}{2}$	1.3397	1.0168

32. $\text{C}_3\text{H}_6\text{O}$, Acetone; $t = 25^\circ\text{C}$
(51); see also 349–358

% B	n_D^t
0.00	1.33232
25.90	1.35009
45.50	1.35940
51.50	1.36135
61.70	1.36261
76.30	1.36315
87.96	1.36208
94.90	1.35957
100.00	1.35545
Max. $n_D^{25} = 1.36320$ at % B = 73.5.	

33. $\text{C}_3\text{H}_6\text{O}_2$, Propionic acid; see
also 359

$t = 19^\circ\text{C}$ (39)			
50.3	1.3730		
56.3	1.3764		
62.5	1.3798		
68.5	1.3830		
74.4	1.3858		
80.0	1.3878		
86.0	1.3891		
89.9	1.3899		
92.9	1.3897		
96.1	1.3891		
97.5	1.3885		
99.0	1.3879		
100.0	1.3872		

% B*	n_D^t	d_4^t	t
8.0930	1.34044	1.00580	19.9
23.7180	1.35397	1.01750	19.8
62.1330	1.38004	1.02511	19.6
68.2130	1.38439	1.02424	18.7
97.7850	1.38760	0.99382	19.8
98.0120	1.38819	0.99403	18.7

g B/l	n_D^{25} (113)	d_4^{25}
221.397	1.35092	1.01362
* Unit not stated, probably wt. %.		

33.1. $\text{C}_3\text{H}_6\text{O}_3$, Lactic acid (113)
93.8597 | 1.34326 | 1.0217934. $\text{C}_3\text{H}_8\text{O}$, *n*-Propyl alcohol;
see also 360, 361

% B	n_D^t
$t = 15^\circ\text{C}$ (38)	
0	1.3333
10	1.3429
20	1.3523
30	1.3590
40	1.3651
50	1.3705
60	1.3754
70	1.3795
80	1.3831
90	1.3860
100	1.3873
$t = 20^\circ\text{C}$ (150)	
0.00	1.33296
9.72	1.34195
26.44	1.35555
28.72	1.35713

34.—(Continued)
% B | n_D^t

$t = 20^\circ\text{C}$ (150).—(Cont'd)	
34.71	1.36072
42.99	1.36526
50.46	1.36899
57.73	1.37243
61.62	1.37415
71.20	1.37798
78.41	1.38053
86.41	1.38299
93.34	1.38451
100.00*	1.38499

Vol. %	n_D^t	d_{15}^{15}
$t = 20^\circ\text{C}$ (12)		
2.85	1.3330	0.9984
3.56	1.3340	0.9958
4.95	1.3365	0.9916
10.08	1.3402	0.9869
20.08	1.3483	0.9760
29.83	1.3533	0.9652
40.00	1.3576	0.9517
50.15	1.3630	0.9340
60.10	1.3680	0.9135
69.99	1.3738	0.8897
80.00	1.3790	0.8638
90.01	1.3840	0.8341
99.5	1.3855	0.8098

* $d_4^{15} = 0.8075$.35. $\text{C}_3\text{H}_8\text{O}$, Isopropyl alcohol
 $t = 20^\circ\text{C}$ (12)

2.85	1.3335	0.9962
3.56	1.3340	0.9952
4.95	1.3375	0.9888
10.08	1.3392	0.9866
20.08	1.3478	0.9755
29.83	1.3542	0.9654
40.00	1.3590	0.9520
50.15	1.3632	0.9345
60.10	1.3678	0.9137
69.99	1.3712	0.8900
80.00	1.3745	0.8640
90.01	1.3769	0.8338
94.97	1.3770	0.8160
99.50	1.3775	0.7953

% B	n_D^t
$t = 15^\circ\text{C}$ (38)	
0	1.3333
10	1.3427
20	1.3522
30	1.3601
40	1.3655
50	1.3700
55	1.3718
60	1.3736
70	1.3764
75	1.3775
80	1.3785
85	1.3792
90	1.3797
95	1.3797
100	1.3792
Max. $n_D^{15} = 1.3798$ at % B = 94.	

36. $\text{C}_3\text{H}_8\text{O}_3$, Glycerol
% B | n_D^t

$t = 25^\circ\text{C}$ (73)	
0	1.3333
5	1.3394
10	1.3455
15	1.3516
20	1.3577
25	1.3641
30	1.3709
35	1.3777
40	1.3846
45	1.3917
50	1.3985
55	1.4058
60	1.4131
65	1.4204
70	1.4281
75	1.4357
80	1.4435
85	1.4506
90	1.4576
95	1.4651
100	1.4730

 $t = 20^\circ\text{C}$ (112) $n_D^{20} = 1.33298 + 0.00011778$ (g
B/l soln.)37. $\text{C}_4\text{H}_6\text{O}_4$, Succinic acid (113)

g B/l	n_D^{25}	d_4^{25}
45.8425	1.33730	1.01077

38. $\text{C}_4\text{H}_6\text{O}_5$, Malic acid (113)

168.079	1.35156	1.05782
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39. $\text{C}_4\text{H}_6\text{O}_6$, Tartaric acid (53);
see also 563, 564

% B	n_D^t	d_4^t
$t = 11^\circ\text{C}$		
0.00	1.3325	
10.45	1.3474	1.0497
17.79	1.3576	1.0871
25.44	1.3684	1.1274
31.65	1.3779	1.1618
38.26	1.3881	1.2006
44.28	1.3979	1.2370
$a = 1.3345$, $b = 1.195$, $c =$ 5.25, $\epsilon = 2$ or 3.		

% B	n_D^t	d_4^t
$t = 11.5^\circ\text{C}$		
24.62	1.3669	1.1221
29.10	1.3742	1.1468
33.49	1.3807	1.1716
37.82	1.3872	1.1969
41.35	1.3925	1.2180
49.35	1.4015	1.2490

% B	n_D^t	d_4^t
$t = 14.3^\circ\text{C}$		
1.07	1.3349	1.0043
2.84	1.3369	1.0122
4.84	1.3395	1.0214
6.93	1.3423	1.0313
7.31	1.3428	1.0335
9.83	1.3462	1.0454

% B	n_D^t	d_4^t
$t = 20^\circ\text{C}$		
0.00	1.3330	
2.00	1.3356	1.0077
4.91	1.3393	1.0211

39.—(Continued)
% B | n_D^t | d_4^t

$t = 20^\circ\text{C}$.—(Cont'd)		
9.61	1.3451	1.0429
18.46	1.3565	1.0864
26.64	1.3686	1.1294
34.22	1.3801	1.1714
41.31	1.3910	1.2131
47.88	1.4023	1.2540

 $a = 1.3330$, $b = 1.185$, $c =$
5.25, $\epsilon = 2$ or 3.

g B/l	n_D^{25} (113)	d_4^{25}
soln., 25°		
73.6565	1.34145	1.02960
200.00	1.35626	1.08440

40. $\text{NH}_4\text{HC}_4\text{H}_4\text{O}_6$, Acid tar-
trate; $t = 18^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3342	1.0031
$\frac{1}{8}$	1.3358	1.0062

41. $\text{C}_4\text{H}_{10}\text{O}$, Trimethyl carbinol
(37)

% B	n_D^{25}	d_4^{25}
0.00	1.33284	0.99713
9.99	1.34316	0.9820
19.97	1.35330	0.9669
29.96	1.36056	0.9455
39.98	1.36635	0.9222
49.96	1.37147	0.8988
59.96	1.37585	0.8753
69.84	1.37935	0.8519
79.92	1.38220	0.8282
89.92	1.38411	0.8044
100.00	1.38548	0.78602

Pulfrich's formula (p. 65)
applies accurately. Data re-
duced to vacuum.42. $\text{C}_4\text{H}_{10}\text{O}_4$, Erythritol (112)
 $n_D^{20} = 1.33298 + 0.00013097$
(g B/l soln.)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3337	1.0015
$\frac{1}{8}$	1.3345	1.0032
$\frac{1}{4}$	1.3366	1.0065
$\frac{1}{2}$	1.3398	1.0131
1	1.3455	1.0261
2	1.3575	1.0510
4	1.3804	1.0973

44. $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$, Tartrate;
 $t = 18^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3344	1.0020
$\frac{1}{8}$	1.3356	1.0045
$\frac{1}{4}$	1.3375	1.0100
$\frac{1}{2}$	1.3419	1.0209
1	1.3495	1.0411
2	1.3642	1.0802
4	1.3931	1.1532

45. $\text{C}_6\text{H}_4\text{O}_2$, 2-Furaldehyde
(132)

t	n_{5876}^t
4.6217 % B	
24.05	1.34107
37.85	1.33902

45.—(Continued)

<i>t</i>	<i>n</i> _D ¹⁵⁷⁶
5.6935 % B	
23.8	1.34310
35.4	1.34143
6.5624 % B	
21.75	1.34496
31.85	1.34351
96.340 % B	
23.7	1.51682
30.3	1.51336
100.000 % B	
22.1	1.52497
32.3	1.51978
46.5	1.51255
75.0	1.49788

46. C₆H₅N, Pyridine; see also 372–374

% B	<i>n</i> _D ^t
<i>t</i> = 15°C (45)	
0	1.3341
5	1.3435
10	1.3532
15	1.3632
20	1.3731
25	1.3829
30	1.3927
35	1.4025
40	1.4123
45	1.4219
50	1.4317
55	1.4414
60	1.4516
65	1.4616
70	1.4710
75	1.4799
80	1.4884
85	1.4960
90	1.5028
95	1.5088
100	1.5136

If 0 < % B < 60, *b* = 1.95, *c* = 0, *ε* = 1 or 2.

<i>t</i> = 25.2°C (152); cf. (82)	
0*	1.33266
11.63	1.35433
20.99	1.37122
31.18	1.38981
41.54	1.40874
50.97	1.42591
60.36	1.44306
71.50	1.46295
81.43	1.47976
91.39	1.49475
100.00†	1.50677

* *d*₄^{25.2} = 0.99971.

† *d*₄^{25.2} = 0.99776.

47. NH₄C₆H₅O₂, Valerate; *t* = 20°C (47)

<i>N</i> _t	<i>n</i> _D ^t	<i>d</i> _t ^t
1/16	1.3340	1.0002
1/8	1.3345	1.0006
1/4	1.3361	1.0015
1/2	1.3386	1.0036

47.—(Continued)

<i>N</i> _t	<i>n</i> _D ^t	<i>d</i> _t ^t
1	1.3440	1.0071
2	1.3545	1.0141
4	1.3751	1.0263

48. C₆H₆O, Phenol (83); 8.2 % B

<i>t</i>	Solution	H ₂ O
	<i>n</i> _D ^t	<i>δ</i> _d
17.6	1.34800	5.0
18	1.34792	5.0
19	1.34755	4.8
20	1.34749	4.5

49. C₆H₇N, Aniline (4); see also 400–402

100 – % B	<i>n</i> _D ²⁰
0.0000	1.58685
1.0484	1.58396
2.1232	1.58114
3.0571	1.57861
<i>n</i> _D ²⁰ = 1.58685 – 0.00270 (100 – %B). <i>α</i> = 3.0 and almost independent of <i>t</i> . Saturated at (100 – % B) = 4.835, for which <i>d</i> ₂₀ ²⁰ = 1.02393.	

50. C₆H₈O₇, Citric acid (113)

g B/l soln., 25°	<i>n</i> _D ²⁵	<i>d</i> _t ²⁵
89.8126	1.34253	1.03039
M _B /l soln., 15°	<i>n</i> _D ¹⁵ (28)	
2.0	1.3800	

51. C₆H₁₂O₆, Fructose (109, 111)

<i>t</i> = 20°C, <i>n</i> _D (H ₂ O) = 1.33298	
Isom.	<i>k</i>
<i>β</i>	1.4366
<i>α</i> , <i>β</i> (c.q.)	1.4100

52. C₆H₁₂O₆, Glucose; *t* = 20°C (109, 111); *n*_D(H₂O) = 1.33298

<i>α</i>	
<i>β</i>	1.423637
<i>α</i> , <i>β</i> (c.q.)	1.437518
<i>α</i> , <i>β</i> (c.q.)	1.4325
g B/l soln., <i>t</i> °	<i>n</i> _D ^t (108)
0	1.33298
253	1.36946*
253	1.36961†
280	1.37380*
280	1.37397‡

* Age of solution: 10 min.

† 24 hr.

‡ 6 hr.

53. C₆H₁₄O₆, Dulcitol (112) *n*_D²⁰ = 1.33298 + 0.00014254 (g B/l soln.)

54. C₆H₁₄O₆, *d*-Mannitol (112) *n*_D²⁰ = 1.33298 + 0.00014216 (g B/l soln.)

55. C₆H₁₄O₆, *d*-Sorbitol (112) *n*_D²⁰ = 1.33298 + 0.00014327 (g B/l soln.)

56. C₆H₁₆N, Triethylamine (83); 5 % B

<i>t</i>	Solution	H ₂ O
	<i>n</i> _D ^t	<i>δ</i> _d
17	1.33840	– 9.5
18	1.33821	– 10.0
19	1.33777	– 10.4
20	1.33798	– 10.5
21	1.33813	– 10.7
22	1.33823	– 10.9
23	1.33835	– 11.3
24	1.33845	– 11.7
25	1.33875	– 11.9

57. (NH₄)₃C₆H₅O₇, Citrate; *t* = 17.5°C (47)

<i>N</i> _t	<i>n</i> _D ^t	<i>d</i> _t ^t
1/16	1.3344	1.0023
1/8	1.3352	1.0046
1/4	1.3372	1.0092
1/2	1.3411	1.0187
1	1.3487	1.0364
2	1.3636	1.0700
4	1.3903	1.1321

58. NH₄C₇H₅O₂, Benzoate; *t* = 20°C (47)

1/16	1/8	1/4
1.3359	1.3376	1.3414
1.0019	1.0040	1.0082

59. NH₄C₇H₅O₃, Salicylate; *t* = 20°C (47)

1/16	1/8	1/4
1.3360	1.3384	1.3429
1.0023	1.0052	1.0111
1/2	1.3521	1.0228
1	1.3692	1.0461

60. C₇H₁₂O₆, Quinic acid (113)

g B/l soln., 25°	<i>n</i> _D ²⁵	<i>d</i> ₄ ²⁵
53.8721	1.34027	1.01722

61. C₇H₁₄O₆, Methylglucoside; 10 % B, *t* = 20°C (110)

<i>n</i> _D ²⁰ (H ₂ O) = 1.33298		
Isom.	<i>n</i> _D ²⁰	<i>d</i> ₄ ²⁰
<i>α</i>	1.34680	1.031022
<i>β</i>	1.34688	1.030670

62. C₈H₈O₂, Phenylacetic acid (113)

g B/l soln., 25°	<i>n</i> _D ²⁵	<i>d</i> ₄ ²⁵
5.8743	1.33357	0.99800

63. C₈H₈O₃, Phenylglycolic acid (113)

84.7143	1.34783	1.01704
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64. C₁₀H₁₄N₂, Nicotine

% B	<i>n</i> _D ^t
<i>t</i> = 15°C (45)	
0	1.3341
5	1.3443
10	1.3546
15	1.3652
20	1.3760
25	1.3868
30	1.3976
35	1.4083

64.—(Continued)

% B	<i>n</i> _D ^t
<i>t</i> = 15°C.—(Cont'd)	
40	1.4193
45	1.4303
50	1.4413
55	1.4523
60	1.4633
65	1.4743
70	1.4852
75	1.4950
80	1.5035
85	1.5118
90	1.5193
95	1.5255
100	1.5300

% B (81)	<i>n</i> _D ^t	<i>t</i>
0.00	1.33274	25.0
3.72	1.34058	22.5
10.01	1.35336	22.9
14.92	1.36321	23.9
24.17	1.38327	22.5
30.08	1.39472	25.5
37.46	1.41073	23.0
44.54	1.42576	24.4
50.24	1.43789	23.8
57.17	1.45324	23.8
63.30	1.46602	24.0
66.78	1.47277	24.5
73.04	1.48582	24.6
79.65	1.49724	25.4
88.66	1.51215	24.8
100.00	1.52682	25.0

*n*_D can be computed by Pulfrich's formula (p. 65) with an accuracy of ±0.0001 or ±0.0002.

65. C₁₂H₂₂O₁₁, Lactose

% B	<i>n</i> _D ^t	<i>d</i> ₄ ^t
<i>t</i> = 18.5°C (53)		
4.65	1.3400	1.0172
7.56	1.3433	1.0273
14.35	1.3551	1.0580
18.47	1.3604	1.0716
22.51	1.3670	1.0888
26.97	1.3746	1.1093

66. C₁₂H₂₂O₁₁, Sucrose

<i>t</i> = 16.5°C (53)		
2.97	1.3377	1.0107
4.63	1.3400	1.0169
4.95	1.3404	1.0181
6.36	1.3425	1.0239
6.86	1.3433	1.0256
8.49	1.3457	1.0325
9.29	1.3470	1.0360
9.72	1.3476	1.0376
11.04	1.3498	1.0433
16.06	1.3577	1.0643
18.36	1.3615	1.0742
21.48	1.3666	1.0888
21.66	1.3669	1.0895
23.99	1.3712	1.1002
29.91	1.3813	1.1280
30.91	1.3836	1.1329
40.09	1.4006	1.1783

66.—(Continued)

% B	n_D^t	d_4^t
$t = 18.5^\circ\text{C}$ (53)		
5.01	1.3406	1.0185
9.77	1.3478	1.0379
14.20	1.3546	1.0561
18.67	1.3618	1.0758
22.92	1.3689	1.0942
26.98	1.3760	1.1134
31.00	1.3835	1.1331
34.80	1.3902	1.1510
38.53	1.3974	1.1694
42.14	1.4042	1.1885
49.12	1.4184	1.2250
59.59	1.4380	1.2789

66.—(Continued)

% B	n_D^t (91)	t
74.55	1.47051	50.3
78.37	1.48063	48.5
78.37	1.47801	60.7
78.37	1.47783	61.4
78.37	1.47500	73.5
78.37	1.47486	74.3
If $72 < \% B < 81$ and $30^\circ < t < 75^\circ$, $n_D^t = 1.28534 + 0.00263 \times (\% B) - (124.1 + 1.267(\% B)) \times t(10)^{-6}$, the fifth figure of n_D^t being unreliable.		
Gelatin, v. p. 76		
Proteins, v. Table 4		

78. $\text{Cd}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33468
0.2	1.33507
0.5	1.34018
1.0	1.34694
2.0	1.36013
4.0	1.38508

79. HgCl_2 ; $t = 18^\circ\text{C}$ (86); see also 572–574

N_t	n_D^t
0.3	1.33668
0.5	1.33900
If $N_{18} = 0.2$, $n_D^{18} = 1.3381$ (148). If g B/l soln., $25^\circ = 54.18$, $n_D^{25} = 1.33712$, $d_4^{25} = 1.04160$ (113).	

79.1. HgI_2 ; see 57179.2. $\text{Hg}(\text{NO}_3)_2$; see 54179.3. $\text{Hg}_2(\text{NO}_3)_2$; see 54280. $\text{Cu}(\text{ClO}_3)_2$; $t = 18^\circ\text{C}$ (86)

N_t	n_D^t
0.5	1.34086
1	1.34830
2	1.36269
4	1.39013

(64)

N_t	n_D^t
0.1	1.33482
0.2	1.33634
0.5	1.34087
1.0	1.34835
2.0	1.36278
4.0	1.39013

81. $\text{Cu}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$ (86)

N_t	n_D^t
0.5	1.34050
1	1.34749
2	1.36130
4	1.38751

(64)

N_t	n_D^t
0.1	1.33473
0.2	1.33619
0.5	1.34050
1.0	1.34756
2.0	1.36138
4.0	1.38756

82. AgF ; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33465
0.2	1.33602
0.5	1.33982
1.0	1.34583
2.0	1.35647
3.0	1.36703

83. AgNO_3 (113); see also 575, 576

g B/l soln., 25°	n_D^{25}	d_4^{25}
169.97	1.34976	1.13615

84. MnCl_2 ; $t = 18^\circ\text{C}$ (86); see also 590

N_t	n_D^t
0.5	1.33978
1	1.34623
2	1.35866
6	1.40498

84.—(Continued)

N_{18} (65)	n_{3256}^{18}	
0.4995	1.36064	
1.013	1.36805	
2.024	1.38220	
4.042	1.40909	
g B/kg A	n_D^{20} (17)	α^*
2.5	1.3355	1.13
6.3	1.3361	1.00
12.6	1.3374	1.13

* If $15^\circ < t < 30^\circ\text{C}$.85. MnBr_2 (86)

N_{18}	n_D^{18}
0.5	1.34183
1	1.35030
2	1.36682
4	1.39898

86. MnSO_4 (17); see also 577, 578, 590

g B/kg A	n_D^{20}	α^*
3.0	1.3353	1.20
7.5	1.3357	1.00
15.0	1.3371	1.00

* If $15^\circ < t < 30^\circ\text{C}$.87. $\text{Mn}(\text{NO}_3)_2$ (86); see also 577, 590

N_{18}	n_D^{18}
0.5	1.33963
1	1.34592
2	1.35810

g B/kg A	n_D^{20} (17)	α^*
3.6	1.3357	1.07
9.0	1.3360	1.07
18.0	1.3378	1.13

* If $15^\circ < t < 30^\circ\text{C}$.88. FeCl_2 ; $t = 18^\circ\text{C}$ (86)

N_t	n_D^t
0.5	1.34038
1	1.34742
2	1.36064
4	1.38631

89. FeCl_3 ; $t = 18^\circ\text{C}$ (86); see also 579, 591

N_t	n_D^t
0.5	1.34055
1	1.34769
2	1.36138
4	1.38805

(Abbe-Zeiss) $t = 20^\circ\text{C}$ (14)

N_t	n_D^t
0.1	1.3350
1.0	1.3480
1	$n_D^{30} = 1.3471$

g B/kg A	n_D^{20} (17)	α^*
3.3	1.3365	1.13
8.3	1.3388	1.20
16.6	1.3431	1.27

* If $15^\circ < t < 30^\circ\text{C}$.90. FeBr_2 (86)

N_{18}	n_D^{18}
0.5	1.34237
1	1.35137
2	1.36910
4	1.40314
5	1.41982

A-B-Table.—(Continued)

66.1. SiO_2 , see 570 (83)66.2. SnO_2 (83)66.3. SnCl_4 , see 23767. $\text{Pb}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$ (86)

N_t	n_D^t
0.5	1.34279
1.0	1.35210
2.0	1.37034

68. $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$, Acetate; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33511
0.2	1.33691
0.5	1.34213
1.0	1.35075
2.0	1.36770
N_t (65)	n_{3256}^t
0.4971	1.36359
0.9725	1.37323
2.006	1.39412

69. ZnCl_2 (Abbe-Zeiss); $t = 20^\circ\text{C}$ (14)

N_t	n_D^t
0.1	1.3350
1.0	1.3470
1.0	$n_D^{30} = 1.3462$

70. $\text{Zn}(\text{ClO}_3)_2$; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33476
0.2	1.33618
0.5	1.34043
1.0	1.34730
2.0	1.36083
4.0	1.38616

71. $\text{Zn}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33466
0.2	1.33603
0.5	1.34008
1.0	1.34675
2.0	1.35971
4.0	1.38415

72. $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2$, Acetate (47)

N_{22}	n_D^{22}	d_{22}^{22}
$\frac{1}{16}$	1.3331	1.0028
$\frac{1}{8}$	1.3345	1.0064
$\frac{1}{4}$	1.3361	1.0140
$\frac{1}{2}$	1.3395	1.0281
1	1.3454	1.0548
2	1.3569	1.1071

73. CdCl_2 (Pulfrich) (49)

% B	n_D^{25}	d_4^{25}
1.599	1.33517	1.0115
4.472	1.33929	1.0368
8.620	1.34499	1.0695
11.600	1.35088	1.1068
18.690	1.36316	1.1803
21.201	1.36833	1.2165
26.076	1.37850	1.2700
31.090	1.38925	1.3401
41.540	1.41710	1.5153

74. $\text{CdCl}_2 \cdot 2\text{H}_2\text{O}$ (Abbe-Zeiss); $t = 20^\circ\text{C}$ (14)

N_t	n_D^t
0.1	1.3348
1.0	1.3465
1	$n_D^{30} = 1.3458$

75. $\text{Cd}(\text{ClO}_3)_2$; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.5	1.34061
1.0	1.34775
2.0	1.36193
4.0	1.38442

76. CdBr_2 (Pulfrich) (49)

% B	n_D^{25}	d_4^{25}
1.05	1.33330	1.0059
2.76	1.33623	1.0212
5.41	1.34001	1.0470
11.03	1.34782	1.1016
15.66	1.35500	1.1509
21.13	1.36425	1.2133
27.51	1.37624	1.2991
40.74	1.40373	1.4918

77. CdI_2 (Pulfrich) (49); see also 254, 320

N_t	n_D^t
0.834	1.33368
3.340	1.33714
3.880	1.33780
6.984	1.34228
13.491	1.35258
20.133	1.36435
26.785	1.37839
39.860	1.41104

(Abbe-Zeiss), $t = 20^\circ\text{C}$ (14)

N_t	n_D^t
0.1	1.3360
1	1.3575
1	$n_D^{30} = 1.3570$

91. Fe₂(SO₄)₃ (17); see also 578, 580, 591

g B/kg A	n_D^{20}	α^*
8.4	1.3363	1.07
20.1	1.3386	1.13
40.2	1.3422	1.20

* If 15° < t < 30°C.

92. Fe(NO₃)₃ (86); see also 580, 580.1, 591

N_{18}	n_D^{18}
0.5	1.34054
1	1.34769
2	1.36178
4	1.38917

g B/kg A	n_D^{20} (17)	α^*
4.8	1.3366	1.07
12.0	1.3391	1.07
24.0	1.3434	1.00

* If 15° < t < 30°C.

93. CoCl₂ (86); see also 581, 592

N_{18}	n_D^{18}
0.5	1.34055
1	1.34759
2	1.36127
4	1.38725

g B/kg A	n_D^{20} (17)	α^*
2.6	1.3360	1.00
6.5	1.3368	1.07
13.1	1.3382	1.07

* If 15° < t < 30°C.

94. Co(ClO ₃) ₂ (86)	
N_{18}	n_D^{18}
0.5	1.34055
1	1.34766
2	1.36133
4	1.38746
5	1.39995

95. CoBr ₂ (86)	
0.5	1.34242
1	1.35149
2	1.36925
4	1.40383

96. CoSO₄ (17); see also 581, 592

g B/kg A	n_D^{20}	α^*
3.1	1.3360	1.07
7.6	1.3366	1.07
15.3	1.3380	1.07

* If 15° < t < 30°C.

97. Co(NO₃)₂ (86); see also 580.1, 592

N_{18}	n_D^{18}
0.5	1.34030
1	1.34706
2	1.36029
4	1.38565
5	1.39795

g B/kg A	n_D^{20} (17)	α^*
3.5	1.3362	1.00
9.0	1.3368	1.00
17.9	1.3384	1.13

* If 15° < t < 30°C.

98. NiCl₂ (86); see also 579, 593

N_{18}	n_D^{18}
0.5	1.34087
1	1.34823
2	1.36240
4	1.38962

98.—(Continued)

N_{18} (65)	n_D^{18} ₂₅₆
0.4960	1.36173
1.002	1.37005
2.037	1.38651
4.014	1.41655

g B/kg A	n_D^{20} (17)	α^*
2.6	1.3357	1.20
6.5	1.3367	1.00
13.1	1.3379	1.13

* If 15° < t < 30°C.

99. Ni(ClO ₃) ₂ (86)	
N_{18}	n_D^{18}
0.5	1.34086
1	1.34823
2	1.36255
4	1.38959

99.1. NiBr ₂ (86)	
0.5	1.34280
1	1.35214
2	1.37053
4	1.40599

100. NiSO₄ (17); see also 593

g B/kg A	n_D^{20}	α^*
3.2	1.3356	1.00
7.7	1.3364	1.00
15.5	1.3374	1.07

* If 15° < t < 30°C.

101. Ni(NO₃)₂ (86); see also 593

N_{18}	n_D^{18}
0.5	1.34058
1	1.34763
2	1.36130
4	1.38743
6	1.41222

g B/kg A	n_D^{20} (17)	α^*
3.7	1.3358	1.13
9.2	1.3368	1.00
18.4	1.3381	1.20

* If 15° < t < 30°C.

101.1. CrO₃ (113); see also 582

g B/l soln., 25°	n_D^{25}	d_4^{25}
3.59075	1.33382	1.00082

102. CrCl₃ (86); see also 594

N_{18}	n_D^{18}
0.3	1.33784
0.5	1.34072
1	1.34790
2	1.36193

g B/kg A	n_D^{20} (17)	α^*
1.6	1.3355	1.07
3.2	1.3365	1.07
7.9	1.3391	1.33

* If 15° < t < 30°C.

103. CrBr ₃ (86)	
N_{18}	n_D^{18}
0.5	1.34275
1	1.35194
2	1.37029

104. Cr₂(SO₄)₃ (17); see also 594

g B/kg A	n_D^{20}	α^*
4.0	1.3349	1.00
8.0	1.3361	1.13
16.1	1.3370	1.07

* If 15° < t < 30°C.

105. Cr(NO₃)₃ (17); see also 594

g B/kg A	n_D^{20}	α^*
2.4	1.3357	1.07
4.8	1.3368	1.07
11.9	1.3393	1.07

* If 15° < t < 30°C.

106. (NH₄)₂CrO₄ (Abbe-Zeiss) (14)

N_{20}	n_D^{20}
0.1	1.3350
1	1.3532
1	$n_D^{30} = 1.3522$

107. MoO₃ (113); see also 535, 547, 551, 553–555, 559–563, 565, 567–569, 582

g B/l soln., 25°	n_D^{25}	d_4^{25}
1.0030	1.33267	0.99781
1.3131	1.33272	0.99814
4.80345	1.33337	1.00119
5.49045	1.33347	1.00146
5.7626	1.33351	1.00186
9.4047	1.33426	1.00441
11.5253	1.33457	1.00660
11.8782	1.33472	1.00721
12.0676	1.33474	1.00708
12.0844	1.33514	1.00832
22.3675	1.33649	1.01554

108. (NH₄)₆Mo₇O₂₄, Crystallized twice (29); see also 564

g B/l soln.	n_D^t	t
10	1.3314	19.6
10	1.3316	20.6
25	1.3343	20.3
200	1.36519*	25

* $d_4^{25} = 1.13560$ (113).109. UO₂(NO₃)₂, Anhydrous (149)

% B	n_D^{17}	d_{17}^{17}
2.80	1.33597	1.0257
5.73	1.33869	1.0510
10.92	1.34417	1.1035
14.26	1.34675	1.1288
16.96	1.35041	1.1625
20.05	1.35412	1.1983
25.58	1.36158	1.2599
29.77	1.36758	1.3247
34.88	1.37489	1.3939
37.85	1.37901	1.4295
39.73	1.38272	1.4669
43.11	1.38804	1.5204
44.02	1.38974	1.5275
47.94	1.39714	1.6155
49.92	1.39889	1.6506
52.04	1.40511	1.7118
53.91	1.40843	1.7480
54.77	1.41155	1.7536

109.1. V₂O₅ (83)

110. AlCl ₃ (86)	
N_{18}	n_D^{18}
0.5	1.33953
1	1.34568
2	1.35736
4	1.37981

111. Al₂(SO₄)₃ (113); see also 545, 583

g B/l soln., 25°	n_D^{25}	d_4^{25}
68.475	1.34710	1.06880

112. Al(NO ₃) ₃ (86)	
N_{18}	n_D^{18}
0.5	1.33932
1	1.34522
2	1.35682
4	1.37887
6	1.39972

113. Al(CNS) ₃ (Kahlbaum) (35)		
M_B/M_A	n_D^{18}	d_4^{18}
36.79	1.41207	1.1582

114. BeCl ₂ ; t = 18°C (86)	
N_t	n_D^t
0.5	1.33783
1	1.34234
2	1.35117
4	1.36857

115. Be(NO ₃) ₂ ; t = 18°C (86)	
0.5	1.33772
1	1.34210
2	1.35082
4	1.36810

116. MgCl ₂ ; t = 18°C (64)	
0.1	1.33448
0.2	1.33567
0.5	1.33930
1.0	1.34511
2.0	1.35636
4.0	1.37751

117. MgCl ₂ ·6H ₂ O (Abbe-Zeiss); t = 20°C (14)	
0.1	1.3346
1	1.3451
1	$n_D^{30} = 1.3442$

118. Mg(ClO ₃) ₂ ; t = 18°C (64)	
0.1	1.33452
0.2	1.33571
0.5	1.33831
1.0	1.34518
2.0	1.35649
4.0	1.33770

119. MgSO ₄ ·7H ₂ O (Abbe-Zeiss); t = 20°C (14)	
0.1	1.3344
1	1.3450
1	$n_D^{30} = 1.3440$

120. Mg(NO ₃) ₂ ; t = 18°C (64)	
0.1	1.33443
0.2	1.33554
0.5	1.33891
1.0	1.34435
2.0	1.35504
4.0	1.37510

121. Mg(C ₂ H ₃ O ₂) ₂ , Acetate; t = 18°C (64)	
0.1	1.33461
0.2	1.33593
0.5	1.33977
1.0	1.34604

121.—(Continued)			125.—(Continued)			131.—(Continued)			140. Ba(C ₂ H ₃ O ₂) ₂ , Acetate (⁶⁴)			
<i>N_t</i>	<i>n_D^t</i>		<i>t</i>	<i>d₄^t</i>	<i>n_D^t</i>	<i>N_t</i>	<i>n_D^t</i>		<i>N₁₈</i>	<i>n_D¹⁸</i>		
2.0	1.35826		8.67% B.—(Cont'd)			4.0	1.38549		0.2	1.33658		
3.0	1.36995		30.0	1.0614	1.34711	5.5	1.40352		0.5	1.34136		
<i>N₂₃</i>	<i>n_D²³ (47)</i>	<i>d₂₃²³</i>	32.5	602	668	132. SrCl ₂ ·6H ₂ O (Abbe-Zeiss);						
$\frac{1}{16}$	1.3333	1.0004	35.0	591	629	<i>t</i> = 20°C (¹⁴)						
$\frac{1}{8}$	1.3340	1.0027	13.22% B			0.1	1.3350		141. Ba(C ₃ H ₅ O ₂) ₂ , Propionate			
$\frac{1}{4}$	1.3355	1.0074	15.0	1.1054	1.35768	1	1.3472		(47)			
$\frac{1}{2}$	1.3386	1.0168	17.5	042	729	1	<i>n_D³⁰</i> = 1.3465		<i>N₂₃</i>	<i>n_D²³</i>	<i>d₂₃²³</i>	
1	1.3448	1.0348	20.0	032	697	133. Sr(ClO ₃) ₂ ; <i>t</i> = 18°C (⁶⁴)						
122. MgCrO ₄ ; <i>t</i> = 18°C (⁸⁶)			22.5	021	665	0.1	1.33475		$\frac{1}{16}$	1.3344	1.0054	
<i>N_t</i>	<i>n_D^t</i>		25.0	009	629	0.2	1.33618		$\frac{1}{8}$	1.3355	1.0109	
0.5	1.34421		27.5	1.0997	588	0.5	1.34041		$\frac{1}{4}$	1.3379	1.0225	
1	1.35473		30.0	985	545	1.0	1.34730		$\frac{1}{2}$	1.3425	1.0448	
2	1.37525		32.5	972	512	2.0	1.36047		142. LiOH (Pulfrich) (¹⁸)			
4	1.41423		35.0	958	473	4.0	1.38516		<i>t</i>	<i>n_D^t</i>		
5	1.43295		17.44% B			10.1 g B/l soln.						
123. CaCl ₂ (Abbe-Zeiss);			15.0	1.1422	1.36570	20.0						1.3375
<i>t</i> = 20°C (¹⁴)			17.5	402	534	0.2						1.3374
0.1	1.3346		20.0	396	493	0.5						1.3367
1.0	1.3461		22.5	383	449	1.0						1.3346
1	<i>n_D³⁰</i> = 1.3452		25.0	371	408	2.0						1.3337
124. Ca(ClO ₃) ₂ ; <i>t</i> = 18°C (⁶⁴)			27.5	357	366	24.3 g B/l soln.						
0.5	1.33997		30.0	344	323	21.0						1.3421
1.0	1.34647		32.5	330	277	25.0						1.3416
2.0	1.35900		35.0	315	239	38.0						1.3399
4.0	1.38255		126. Ca(CNS) ₂ (Kahlbaum)			46.0						1.3386
125. Ca(NO ₃) ₂ , Anhydrous; <i>t</i> =			(35)			44.6 g B/l soln.						
18°C (⁶⁴); see also 558			<i>M_B/M_A</i>	<i>d₄¹⁷</i>	<i>n_D¹⁷</i>	17.0						1.3504
0.1	1.33454		17.55	1.2185	1.43356	21.0						1.3503
0.2	1.33578		127. Ca(CHO ₂) ₂ , Formate; <i>t</i> =			22.3						1.3502
0.5	1.33947		20°C (⁴⁷)			30.0						1.3490
1.0	1.34541		<i>N_t</i>	<i>d₄^t</i>	<i>n_D^t</i>	45.9						1.3468
2.0	1.35677		$\frac{1}{16}$	1.0022	1.3336	98.2 g B/l soln.						
4.0	1.37789		$\frac{1}{8}$	1.0052	1.3341	17.0						1.3682
5.5	1.39257		$\frac{1}{4}$	1.0109	1.3353	21.0						1.3677
<i>t</i>	<i>d₄^t</i>	<i>n_D^t</i>	$\frac{1}{2}$	1.0220	1.3384	22.6						1.3675
0% B			128. Ca(C ₂ H ₃ O ₂) ₂ ·H ₂ O, Ace-			42.0						1.3645
15.0	0.9990	1.33351	tate; <i>t</i> = 20°C (⁴⁷)			43.0						1.3643
17.5	86	329	$\frac{1}{16}$	1.0022	1.3341	143. LiCl (¹⁰)						
20.0	81	304	$\frac{1}{8}$	1.0050	1.3358	% B						<i>n_D²⁵</i>
22.5	76	278	$\frac{1}{4}$	1.0107	1.3376	0.6254						1.33388
25.0	70	257	$\frac{1}{2}$	1.0216	1.3408	0.6977						1.33405
27.5	63	233	1	1.0426	1.3471	0.9329						1.33456
30.0	56	203	2	1.0825	1.3585	0.9578						1.33446
32.5	48	181	129. Ca(C ₃ H ₅ O ₃) ₂ ·3H ₂ O, Lac-			0.9688						1.33460
35.0	40	149	tate; <i>t</i> = 22.5°C (⁴⁷)			1.4114						1.33555
4.38% B			$\frac{1}{16}$	1.0025	1.3339	2.7648						1.33833
15.0	1.0337	1.34153	$\frac{1}{8}$	1.0060	1.3350	2.7703						1.33842
17.5	331	126	$\frac{1}{4}$	1.0129	1.3374	5.7352						1.34465
20.0	324	104	$\frac{1}{2}$	1.0265	1.3416	6.5965						1.34653
22.5	317	076	130. Ca(C ₄ H ₇ O ₂) ₂ , Isobutyrate;			10.5860						1.35494
25.0	309	041	<i>t</i> = 22.5°C (⁴⁷)			13.1099						1.36024
27.5	301	010	$\frac{1}{16}$	1.0017	1.3339	1						1.34174
30.0	291	1.33981	$\frac{1}{8}$	1.0044	1.3352	1						<i>n_D¹⁸ (⁶⁴)</i>
32.5	283	949	$\frac{1}{4}$	1.0100	1.3373	0.5						1.33774
35.0	273	914	$\frac{1}{2}$	1.0208	1.3420	1.0						1.34207
8.67% B			1	1.0414	1.3507	2.0						1.35053
15.0	1.0671	1.34915	131. SrCl ₂ ; <i>t</i> = 18°C (⁶⁴)			4.0						1.36651
17.5	662	882	<i>N_t</i>	<i>n_D^t</i>		<i>t</i> = 20°C (⁵⁶)						
20.0	653	848	0.1	1.33471		1						1.34174
22.5	644	822	0.2	1.33613		% B						<i>n_D²⁵ (⁹⁵)</i>
25.0	634	779	0.5	1.34033		0.00						1.3326
27.5	624	740	1.0	1.34711		10.68						1.3565
			2.0	1.36036		15.27						1.3673

143.—(Continued)

% B	n_D^{25} (95)
21.10	1.3838
31.50	1.4069
36.36	1.4149
40.76	1.4289
43.33	1.4343

(Pulfrich) (18)

t	n_D^t
69.2 g B/l soln.	
17.0	1.3477
19.3	1.3475
20.1	1.3474
40.8	1.3456
53.0	1.3443
206.2 g B/l soln.	
17.0	1.3711
20.0	1.3708
34.0	1.3693
339.6 g B/l soln.	
18.0	1.3979
20.2	1.3977
29.0	1.3966
35.0	1.3960
49.0	1.3943
59.0	1.3930
604.0 g B/l soln.	
18.3	1.4373
20.1	1.4371
28.0	1.4357
46.0	1.4334

144. $\text{LiCl} \cdot 2\text{H}_2\text{O}$ (Abbe-Zeiss)
(14)

N_{20}	n_D^{20}
0.1	1.3340
1.0	1.3420
1	$n_D^{30} = 1.3410$

145. LiClO_3 (65)

N_{18}	n_D^{18} (3256)
0.5124	1.35825
1.023	1.36313
2.043	1.37211
4.090	1.39000

146. LiBr (10)

% B	n_D^{25}	d_4^{25}
0.1980	1.33273	0.9984
0.3328	1.33300	0.9995
0.3889	1.33307	0.9999
0.4313	1.33309	1.0001
0.8136	1.33369	1.0028
1.0244	1.33401	1.0044
1.4355	1.33466	1.00745
1.6802	1.33499	1.0092
1.8718	1.33530	1.0108
3.5637	1.33788	1.0233
3.5919	1.33793	1.0234
3.7527	1.33825	1.0245
4.2994	1.33905	1.0287
4.6222	1.33954	1.0309
6.1940	1.34200	1.04335
14.966	1.35662	1.1153
18.190	1.36254	1.1434
32.55	1.39194	1.2889

146.—(Continued)

N_{18}	n_D^{18} (64)
0.5	1.33969
1.0	1.34600
2.0	1.35833
4.0	1.38223

147. LiI (10)

% B	n_D^{25}	d_4^{25}
1.1083	1.33424	1.00509
1.4231	1.33468	1.00742
1.4512	1.33473	1.00755
2.1422	1.33580	1.01282
2.3577	1.33620	1.01438
2.5287	1.33641	1.01567
4.9689	1.34033	1.03405
12.3103	1.35311	1.09490
15.4751	1.35908	1.12291

N_{18}	n_D^{18} (64)
0.2	1.33740
0.5	1.34357
1.0	1.35283
2.0	1.37428
4.0	1.41506

148. LiIO_3 (64)

N_{18}	n_D^{18} (64)
0.1	1.33575
0.2	1.33823
0.5	1.34559
1.0	1.35767
2.0	1.38105
3.0	1.40367

149. Li_2SO_4 (86)

N_{18}	n_D^{18}
0.5	1.33802
1	1.34247
2	1.35078
4	1.36544
5	1.37207

N_{18} (65)	n_D^{18} (3256)
0.4307	1.35764
0.871	1.36175
1.744	1.36943
3.493	1.38324

150. LiNO_3 ; $t = 18^\circ\text{C}$ (64); see also 575

N_t	n_D^t
0.5	1.33644
1.0	1.33951
2.0	1.34555
4.0	1.35703

 $t = 20^\circ\text{C}$ (56)

N_t	n_D^t
0.5	1.33648
1.0	1.34123

If g B/l soln., $25^\circ = 69.07$,
 $n_D^{25} = 1.33800$, $d_4^{25} = 1.02338$
(113).151. $\text{LiC}_2\text{H}_3\text{O}_2$, Acetate; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33428
0.2	1.33528
0.5	1.33824
1.0	1.34312
2.0	1.35271
4.0	1.37119

151.—(Continued)

N_{18} (65)	n_D^{18} (3256)
0.4885	1.35871
1.047	1.36479
2.022	1.37506
4.033	1.39620

152. LiCNS (65)

N_{18}	n_D^{18} (64)
0.5109	1.36371
1.031	1.37427
2.082	1.39530
3.465	1.42285
0.5	1.33971
1.0	1.34566
2.0	1.35781
3.0	1.36993

153. Li_2CrO_4 (86)

N_{18}	n_D^{18}
0.3	1.33916
0.5	1.34297
1	1.35242
2	1.37079
4	1.40591

(64)

N_{18}	n_D^{18}
0.1	1.33529
0.2	1.33727
0.5	1.34307
1.0	1.35251
2.0	1.37095
4.0	1.40612

154. $\text{Li}_2\text{Cr}_2\text{O}_7$ (86)

N_{18}	n_D^{18}
0.3	1.34093
0.5	1.34603
1	1.35862

154.1. Na_2O ; see 570155. NaOH (28); see also 536, 538, 566

N_t	n_D^t	t
0.5	1.3380	21
2.0	1.3535	15

156. NaCl (10); see also 230, 584

% B	n_D^{25}	d_4^{25}
0.5280	1.33342	1.00079
0.5493	1.33341	1.00098
0.9980	1.33417	1.00413
1.0618	1.33433	1.00432
1.1068	1.33438	1.00477
5.3562	1.34169	1.03488
5.4131	1.34179	1.03532
14.344	1.35747	1.10146

(138)

% B	n_D^t
5	1.34172
10	1.35021
15	1.35893
20	1.36829

N_t	n_D^t
$t = 18^\circ\text{C}$ (64)	
0.5	1.33834
1.0	1.34318
2.0	1.35241
4.0	1.36959

156.—(Continued)

N_t	n_D^t
$t = 22.7^\circ\text{C}$ (13)	
$\frac{1}{4}$	1.33400
$\frac{1}{2}$	1.33576
1	1.33929

 $t = 20^\circ\text{C}$ (56)

N_t	n_D^t
1	1.34277

 $t = 20^\circ\text{C}$ (14)

N_t	n_D^t
0.1	1.3341

N_t	n_D^t
1	1.3431

N_t	n_D^t
1	$n_D^{30} = 1.3423$

If g B/l soln., $25^\circ = 58.5$,
 $n_D^{25} = 1.34223$, $d_4^{25} = 1.03704$
(113).157. NaClO_3 ; $t = 18^\circ\text{C}$ (64)

N_{18}	n_D^{18}
0.1	1.33431
0.2	1.33532
0.5	1.33833
1.0	1.34313
2.0	1.35229
4.0	1.36916

158. NaBr (10)

% B	n_D^{25}	d_4^{25}
0.4857	1.3311	1.00074
0.9110	1.33370	1.0041
1.1162	1.33402	1.0058
1.9817	1.33522	1.0123
2.1044	1.33535	1.01354
2.8104	1.33639	1.01931
2.9218	1.33649	1.0198
4.5543	1.33883	1.03268
4.6241	1.33890	1.03320
6.5288	1.34159	1.0490
7.2055	1.34257	1.0544
7.3936	1.34291	1.05600
8.8063	1.34501	1.06832
17.261	1.35822	1.14479
46.06	1.41841	1.5005

N_{18}	n_D^{18} (64)
0.5	1.34031
1.0	1.34718
2.0	1.36021
4.0	1.38611

159. NaI (10)

% B	n_D^{25}	d_4^{25}
0.5723	1.33333	1.00154
0.7125	1.33352	1.00258
0.7137	1.33353	1.00261
0.7469	1.33362	1.00294
3.7111	1.33793	1.02588
3.8603	1.33817	1.02716
6.8272	1.34278	1.05152
18.4384	1.36281	1.15808
30.418	1.38783	1.29156

N_{18}	n_D^{18} (64)
0.5	1.34411
1.0	1.35476
2.0	1.37585
4.0	1.41763

160. Na_2SO_4 (35), Best commercial salt

M_B/M_A	n_D^t	d_4^t	t
74.9	1.34745*	1.0880	15
74.9	1.34771†	1.0884	13.5
72.4	1.34694‡	1.0872	15
71.2	1.34855‡	1.0938	13.5
65.8	1.34783‡	1.0984	17

* Ignited in Pt.

† Dried at 100°.

‡ Recrystallized from H_2O , air-dried.161. NaNO_3 ; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33427
0.2	1.33522
0.5	1.33802
1.0	1.34250
2.0	1.35086
4.0	1.36622
$t = 20^\circ\text{C}$ (56)	
0.5	1.33751
1	1.34174
(Abbe- <i>Zeiss</i>) $t = 20^\circ\text{C}$ (14)	
0.1	1.3341
1	1.3420
1	$n_D^{30} = 1.3411$

162. NaN_3 (Pulfrich) (19)

g B/l soln.	n_D^t	t
100	1.35226	15
	1.35144	20.0
	1.35071	24.5
$\alpha = 1.63$		
200	1.36953	15.8
	1.36883	20.0
	1.36808	24.5
$\alpha = 1.66$		
300	1.38622	16.6
	1.38549	20.0
	1.38527	21
$\alpha = 2.16$		
340	1.39296	15.7
	1.39189	20.0
	1.39102	23.5
$\alpha = 2.49$		

163. $\text{Na}_2\text{C}_2\text{O}_4$, Oxalate; $t = 19.5^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3340	1.0031
$\frac{1}{8}$	1.3347	1.0065
$\frac{1}{4}$	1.3360	1.0132
$\frac{1}{2}$	1.3388	1.0269

164. NaCHO_2 , Formate (47)

$N_{20.5}$	$n_D^{20.5}$	$d_{20.5}^{20.5}$
$\frac{1}{16}$	1.3334	1.0016
$\frac{1}{8}$	1.3337	1.0044
$\frac{1}{4}$	1.3345	1.0092
$\frac{1}{2}$	1.3365	1.0192
1	1.3401	1.0387
2	1.3470	1.0769
4	1.3593	1.1490

165. NaHCO_3 (Abbe-*Zeiss*)
 $t = 20^\circ\text{C}$ (14)

N_t	n_D^t
0.1	1.3341
1	1.3441
1	$n_D^{30} = 1.3432$

166. $\text{NaC}_2\text{H}_3\text{O}_2$, Acetate; $t = 18^\circ\text{C}$ (64); see also 255

	n_D^{25} (84)	d_0^{25}
0.1	1.33442	
0.5	1.33883	
1.0	1.34414	
2.0	1.35423	
4.0	1.37298	
% B		
0	1.33253	0.9969
5	1.33463	1.013

167. $\text{NaC}_2\text{H}_3\text{O}_2 \cdot 3\text{H}_2\text{O}$, Acetate (47)

N_{20}	n_D^{20}	d_{20}^{20}
$\frac{1}{16}$	1.3333	1.0012
$\frac{1}{8}$	1.3340	1.0038
$\frac{1}{4}$	1.3353	1.0086
$\frac{1}{2}$	1.3378	1.0181
1	1.3428	1.0367
2	1.3526	1.0725
4	1.3706	1.1406

168. $\text{NaC}_3\text{H}_5\text{O}_2$, Propionate; $t = 20^\circ\text{C}$ (47); see also 258

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3335	1.0011
$\frac{1}{8}$	1.3343	1.0034
$\frac{1}{4}$	1.3360	1.0079
$\frac{1}{2}$	1.3392	1.0170
1	1.3455	1.0347
2	1.3580	1.0689
4	1.3805	1.1324

169. $\text{NaHC}_4\text{H}_4\text{O}_6$, Acid tartrate; $t = 19.5^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3342	1.0031
$\frac{1}{8}$	1.3351	1.0063
$\frac{1}{4}$	1.3366	1.0127
$\frac{1}{2}$	1.3396	1.0250
1	1.3454	1.0496

170. $\text{NaC}_4\text{H}_7\text{O}_2$, Butyrate; $t = 20.5^\circ\text{C}$ (47); see also 261

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3339	1.0015
$\frac{1}{8}$	1.3350	1.0039
$\frac{1}{4}$	1.3372	1.0081
$\frac{1}{2}$	1.3410	1.0170
1	1.3485	1.0341
2	1.3633	1.0670
4	1.3889	1.1202
% B	n_D^{25} (84)	d_0^{25}
0	1.33253	0.9969
5	1.33470	1.014

171. $\text{NaC}_4\text{H}_7\text{O}_2$, Isobutyrate; $t = 22.5^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3338	1.0013
$\frac{1}{8}$	1.3348	1.0039
$\frac{1}{4}$	1.3371	1.0091
$\frac{1}{2}$	1.3410	1.0189
1	1.3492	1.0383
2	1.3650	1.0766
4	1.3916	1.1388

171.1. $\text{NaC}_5\text{H}_9\text{O}_2$, Valerate; see 265172. $\text{NaC}_5\text{H}_9\text{O}_2$, Isovalerate; $t = 22.5^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3339	1.0009
$\frac{1}{8}$	1.3351	1.0030
$\frac{1}{4}$	1.3373	1.0073
$\frac{1}{2}$	1.3417	1.0162
1	1.3506	1.0331
2	1.3677	1.0632
4	1.4000	1.1052

172.1. $\text{NaC}_7\text{H}_4\text{NO}_4$, *o*-Nitrobenzoate; see 286172.2. $\text{NaC}_7\text{H}_4\text{NO}_4$, *m*-Nitrobenzoate; see 287172.3. $\text{NaC}_7\text{H}_4\text{NO}_4$, *p*-Nitrobenzoate; see 288173. $\text{NaC}_7\text{H}_5\text{O}_2$, Benzoate; $t = 20^\circ\text{C}$ (47); see also 294

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3351	1.0033
$\frac{1}{8}$	1.3374	1.0071
$\frac{1}{4}$	1.3416	1.0152
$\frac{1}{2}$	1.3504	1.0303
1	1.3662	1.0602
2	1.3981	1.1169

174. $\text{NaC}_7\text{H}_5\text{O}_3$, Salicylate; $t = 19^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3352	1.0045
$\frac{1}{8}$	1.3375	1.0090
$\frac{1}{4}$	1.3421	1.0183
$\frac{1}{2}$	1.3512	1.0368
1	1.3687	1.0728
2	1.4035	1.1425

175. $\text{NaC}_7\text{H}_5\text{O}_3$, *m*-Hydroxybenzoate; $t = 23^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3352	1.0033
$\frac{1}{8}$	1.3370	1.0079
$\frac{1}{4}$	1.3411	1.0168
$\frac{1}{2}$	1.3501	1.0336

176. $\text{NaC}_8\text{H}_7\text{O}_2$, *o*-Toluate $t = 24^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3349	1.0019
$\frac{1}{8}$	1.3370	1.0056
$\frac{1}{4}$	1.3412	1.0130
$\frac{1}{2}$	1.3505	1.0278
1	1.3701	1.0563

177. $\text{NaC}_8\text{H}_7\text{O}_2$, *m*-Toluate $t = 24^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3341	1.0026
$\frac{1}{8}$	1.3350	1.0060
$\frac{1}{4}$	1.3372	1.0132
$\frac{1}{2}$	1.3491	1.0267
1	1.3647	1.0527

178. $\text{NaC}_8\text{H}_7\text{O}_2$, *p*-Toluate $t = 24^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3346	1.0024
$\frac{1}{8}$	1.3367	1.0068
$\frac{1}{4}$	1.3409	1.0154
$\frac{1}{2}$	1.3493	1.0323

179. $\text{NaC}_8\text{H}_{15}\text{O}_2$, *n*-Octoate $t = 22^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{4}$	1.3390	1.0042
1	1.3566	1.0174

180. $\text{NaC}_{10}\text{H}_{19}\text{O}_2$, *n*-Decoate; $t = 25.5^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3348	1.0012
$\frac{1}{8}$	1.3363	1.0023
$\frac{1}{4}$	1.3397	1.0056
$\frac{1}{2}$	1.3465	1.0122
1	1.3603	1.0234

181. $\text{NaC}_{16}\text{H}_{31}\text{O}_2$, Palmitate (85); see also 341g B/l soln., 70° | n_D^{70}

Pure; from pure acid and alkali	n_D^{70}
30.4	1.32935
40.7	1.33078
51.9	1.33223
62.3	1.33362

Purified commercial material

N_t	n_D^t
28.9	1.32935
33.7	1.33050
45.2	1.33147
52.3	1.33293
64.7	1.33455
72.1	1.33549
86.8	1.33777

182. $\text{NaC}_{18}\text{H}_{33}\text{O}_2$, Oleate (85); see also 344

Pure; from pure acid and alkali

N_t	n_D^t
38.8	1.33078
49.7	1.33223
69.2	1.33503
100.4	1.33985
126.8	1.34351
149.0	1.34715
177.5	1.35122

183. $\text{NaC}_{18}\text{H}_{35}\text{O}_2$, Stearate (85) Purified commercial material

N_t	n_D^t
24.2	1.32855
28.4	1.32921
35.7	1.33042
44.9	1.33132

For the above and other soaps, see also Vol. V, p. 456, 458.

184. $\text{Na}_2\text{C}_4\text{H}_4\text{O}_4$, Succinate

N_t	n_D^t	d_4^t
$t = 22^\circ\text{C}$ (47)		
$\frac{1}{16}$	1.3335	1.0020
$\frac{1}{8}$	1.3343	1.0051
$\frac{1}{4}$	1.3360	1.0111
$\frac{1}{2}$	1.3389	1.0231
1	1.3452	1.0465
2	1.3568	1.0915
4	1.3791	1.1772

185. $\text{Na}_2\text{C}_4\text{H}_4\text{O}_6$, Tartrate $t = 19^\circ\text{C}$ (47)

N_t	n_D^t	d_4^t
$\frac{1}{16}$	1.3343	1.0036
$\frac{1}{8}$	1.3352	1.0072
$\frac{1}{4}$	1.3368	1.0144
$\frac{1}{2}$	1.3400	1.0284
1	1.3462	1.0561
2	1.3578	1.1094
4	1.3797	1.2115

186. $\text{Na}_2\text{C}_8\text{H}_4\text{O}_4$, Phthalate

N_t	n_D^t	d_4^t
$t = 23^\circ\text{C}$ (47)		
$\frac{1}{16}$	1.3343	1.0024
$\frac{1}{8}$	1.3359	1.0063
$\frac{1}{4}$	1.3384	1.0139
$\frac{1}{2}$	1.3440	1.0286
1	1.3548	1.0576

187. $\text{Na}_2\text{C}_8\text{H}_4\text{O}_4$, Isophthalate

N_t	n_D^t	d_4^t
$t = 23^\circ\text{C}$ (47)		
$\frac{1}{16}$	1.3341	1.0019
$\frac{1}{8}$	1.3355	1.0056
$\frac{1}{4}$	1.3382	1.0123
$\frac{1}{2}$	1.3436	1.0256
1	1.3542	1.0523
2	1.3747	1.1041

188. $\text{Na}(\text{C}_2\text{H}_5\text{SO}_4)$, Ethylsulfate, best commercial material (35)

M_B/M_A	n_D^t	d_4^t	t
17.40	1.36387*	1.1689	14
16.71	1.36360†	1.1699	12.5
12.39	1.37431	1.2380	13.5

* Recrystallized from $\text{C}_2\text{H}_5\text{OH}$, dried at 100°C .† Recrystallized from $\text{C}_2\text{H}_5\text{OH}$, air-dried.188.1. $\text{NaC}_7\text{H}_5\text{N}_2\text{O}_4$, *p*-Nitrophenylnitromethane; see 293189. NaCNS (64)

N_{18}	n_D^{18}
0.5	1.33990
1.0	1.34642
2.0	1.35927
4.0	1.38387

M_B/M_A	n_D^{18} (35)	d_4^{18}
11.27	1.40250*	1.1600
6.66	1.43336*	1.2306
5.66	1.44461†	1.2599

* Crystallized from 96% $\text{C}_2\text{H}_5\text{OH}$.

† Kahlbaum's material.

190. Na_2SiO_3 (64); see also 570

N_{18}	n_D^{18}
0.1	1.33474
0.2	1.33615
0.5	1.34019
1.0	1.34657
2.0	1.35859
4.0	1.38011

191. Na_2CrO_4 (86)

N_t	n_D^t	t
0.3	1.33941	
0.5	1.34342	
1	1.35329	
2	1.37234	

192. KOH (28); see also 539, 548-550

N_t	n_D^t	t
1.0	1.3439	15
1.0	1.3427	25
2.0	1.3538	12*
2.0	1.3530	17.5

* $t = 12$ to 12.5°C .193. KCl (10); see also 230, 572, 584

% B	n_D^{25}	d_4^{25}
0.9466	1.33376	1.00303
0.9716	1.33380	1.0031
0.9769	1.33380	1.0032
0.9983	1.33382	1.0033
1.0013	1.33388	1.0036
2.4297	1.33577	1.0122
2.4623	1.33581	1.0124
4.6474	1.33871	1.02654
4.8150	1.33896	1.0285
4.8318	1.33896	1.0281
4.8340	1.33896	1.0282
7.1573	1.34215	1.0428
7.1699	1.34215	1.0430
9.0221	1.34463	1.0549
9.4153	1.34517	1.0577
9.5004	1.34528	1.05814
13.758	1.35122	1.0865
17.852	1.35678	1.1155
17.898	1.35687	1.1160
21.522	1.36202	1.1426
21.770	1.36238	1.1441

(138)

% B

 n_D^{25}

5

1.33931

10

1.34643

15

1.35035

20

1.35992

If g B/l soln., $25^\circ = 74.6$, $n_D^{25} = 1.34208$, $d_4^{25} = 1.04296$ (113). $t = 18^\circ\text{C}$ (64) N_t n_D^t

0.1

1.33423

0.2*

1.33525

0.5

1.33825

1.0

1.34299

2.0

1.35215

3.0

1.36053

 $t = 20^\circ\text{C}$ (56)

1

1.34260

(Abbe) $t = 20^\circ\text{C}$ (14)

0.1

1.3341†

1

1.3428‡

2

1.3518

3

1.3603

* $n_D^{18} = 1.33513$ (148).† $n_D^{30} = 1.3329$.‡ $n_D^{30} = 1.3420$.

194.—(Continued)

% B	n_D^{25}	d_4^{25}
7.8856	1.34200	1.05543
8.8542	1.34327	1.06317
9.7228	1.34435	1.06977
10.7476	1.34575	1.07881
21.017	1.35984	1.16718

 N_t n_D^t $t = 18^\circ\text{C}$ (64)

0.5

1.34011

1.0

1.34658

2.0

1.35967

4.0

1.38409

(Abbe-Zeiss) $t = 20^\circ\text{C}$ (14)

0.1

1.3345

1

1.3470

1

 $n_D^{30} = 1.3461$ 195. KI (10); see also 573, 585

% B	n_D^{25}	d_4^{25}
0.4379	1.33306	1.00045
0.9151	1.33367	1.00382
1.2259	1.33409	1.00601
2.3607	1.33554	1.01419
3.1122	1.33658	1.01986
5.1029	1.33927	1.03515
8.5864	1.34422	1.06282
25.604	1.37194	1.2200

 N_t n_D^t $t = 18^\circ\text{C}$ (64)

0.5

1.34411

1.0

1.35484

2.0

1.37581

4.0

1.41599

(Abbe-Zeiss) $t = 20^\circ\text{C}$ (14)

0.1

1.3351

1

1.3540

1

 $n_D^{30} = 1.3530$ If g B/l soln. = 33.10, $n_D^{25} = 1.33676$, $d_4^{25} = 1.02093$ (113).196. KHSO_4 (Abbe-Zeiss); $t = 20^\circ\text{C}$ (14)

N_t	n_D^t
0.1	1.3349
1	1.3465
1	$n_D^{30} = 1.3455$

197. K_2SO_4 (35); Best commercial material; see also 546, 583

M_B/M_A	n_D^t	d_4^t	t
107.4	1.34372*	1.0705	14
100.53	1.34402†	1.0718	14
100.0	1.34344†	1.0715	17
100.0	1.34394	1.0727	11
99.39	1.34394	1.0735	10
99.2	1.34361‡	1.0724	15.5
90.9	1.34436	1.0779	14

(Abbe-Zeiss) $t = 20^\circ\text{C}$ (14) N_{20} n_D^{20}

0.1

1.3341

1.0

1.3432

1

 $n_D^{30} = 1.3422$

197.—(Continued)

If g B/l soln., $25^\circ = 33.872$, $n_D^{25} = 1.33661$, $d_4^{25} = 1.02437$ (113).* Recrystallized from H_2O .† Recrystallized from H_2O , dried at 100°C .‡ Not recrystallized, dried at 100°C .198. KN_3 (Pulfrich) (19)

g B/l soln.	n_D^t	t
100	1.34825	16.5
	1.34774*	20.0
	1.34731	23.0
	$\alpha = 1.45$	
200	1.36220	17.1
	1.36174*	20.0
	1.36148	21.6
	$\alpha = 1.6$	
300	1.37620	15.5
	1.37527*	20.0
	1.37480	22.3
	$\alpha = 2.06$	
360	1.38385	15.5
	1.38291*	20.0
	1.38208	24
	$\alpha = 2.08$	

* Interpolated.

199. KNO_3 ; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33426
0.2	1.33520
0.5	1.33801
1.0	1.34244
2.0	1.35066
	$t = 20^\circ\text{C}$ (56)
0.5	1.33743
1.0	1.34182
	(Abbe-Zeiss) $t = 20^\circ\text{C}$ (14)
0.1	1.3341
1	1.3419
1	$n_D^{30} = 1.3410$

200. K_2CO_3 (Abbe-Zeiss); $t = 20^\circ\text{C}$ (14)

N_t	n_D^t
0.1	1.3341
1	1.3441
1	$n_D^{30} = 1.3431$

201. $\text{K}_2\text{C}_2\text{O}_4$, Oxalate (47)

N_{17}	n_D^{17}	d_{17}^{17}	
$\frac{1}{16}$	1.3344	1.0034	
$\frac{1}{8}$	1.3349	1.0070	
$\frac{1}{4}$	1.3361	1.0145	
$\frac{1}{2}$	1.3395	1.0293	
1	1.3442	1.0576	
2	1.3543	1.1129	
M_B/M_A	n_D^t (35)	d_4^t	t
54.30	1.35344	1.1111	13.5
27.77	1.36723*	1.1972	17

* Recrystallized from dilute C_2H_5OH .

* Recrystallized from dilute $\text{C}_2\text{H}_5\text{OH}$.202. KHCO_3 (Abbe-Zeiss) (14)

N_{20}	n_D^{20}
0.1	1.3341
1	1.3440
1	$n_D^{30} = 1.3431$

203. KCHO_2 , Formate
 N_t | n_D^t | d_4^t
 $t = 21^\circ\text{C}$ (47)

$\frac{1}{16}$	1.3331	1.0023
$\frac{1}{8}$	1.33371	1.0053
$\frac{1}{4}$	1.3349	1.0112
$\frac{1}{2}$	1.3371	1.0243
1	1.3409	1.0461
2	1.3491	1.0909
4	1.3601	1.1763

204. $\text{KC}_2\text{H}_3\text{O}_2$, Acetate; $t = 18^\circ\text{C}$ (64)

N_{18}	n_D^{18}
0.1	1.33444
0.2	1.33555
0.5	1.33888
1.0	1.34439
2.0	1.35487
4.0	1.37402

N_t	n_D^t (47)	d_4^t
$\frac{1}{16}$	1.3340	1.0027
$\frac{1}{8}$	1.3346	1.0054
$\frac{1}{4}$	1.3361	1.0108
$\frac{1}{2}$	1.3389	1.0214
1	1.3439	1.0424
2	1.3537	1.0830
4	1.3730	1.1609

205. $\text{KC}_3\text{H}_5\text{O}_2$, Propionate
 $t = 20^\circ\text{C}$ (47)

$\frac{1}{16}$	1.3340	1.0019
$\frac{1}{8}$	1.3348	1.0048
$\frac{1}{4}$	1.3364	1.0103
$\frac{1}{2}$	1.3396	1.0215
1	1.3464	1.0438
2	1.3592	1.0866
4	1.3785	1.1443

206. $\text{KC}_4\text{H}_7\text{O}_2$, Butyrate
 $t = 20^\circ\text{C}$ (47)

$\frac{1}{16}$	1.3336	1.0023
$\frac{1}{8}$	1.3350	1.0051
$\frac{1}{4}$	1.3371	1.0106
$\frac{1}{2}$	1.3411	1.0219
1	1.3489	1.0439
2	1.3641	1.0864
4	1.3904	1.1579

207. $\text{KC}_4\text{H}_7\text{O}_2$, Isobutyrate
 $t = 25^\circ\text{C}$ (47)

$\frac{1}{16}$	1.3336	1.0011
$\frac{1}{8}$	1.3346	1.0042
$\frac{1}{4}$	1.3366	1.0100
$\frac{1}{2}$	1.3408	1.0218
1	1.3485	1.0448
2	1.3640	1.0890
4	1.3909	1.1678

208. $\text{KC}_6\text{H}_5\text{O}_2$, Benzoate
 $t = 18.5^\circ\text{C}$ (47)

$\frac{1}{16}$	1.3350	1.0037
$\frac{1}{8}$	1.3368	1.0078
$\frac{1}{4}$	1.3408	1.0159
$\frac{1}{2}$	1.3490	1.0322

209. $\text{KC}_{16}\text{H}_{31}\text{O}_2$, Palmitate
 (85); see also 340 and Vol. V,
 p. 456, 458

Purified commercial material
 g B/l soln., 70° | n_D^{70}

33	1.32935
38.2	1.33034
47.3	1.33162
56.2	1.33277
66.3	1.33424
75.7	1.33564
91.5	1.33762

210. $\text{K}_2\text{C}_4\text{H}_4\text{O}_4$, Succinate

N_t	n_D^t	d_4^t
$t = 19^\circ\text{C}$ (47)		
$\frac{1}{16}$	1.3337	1.0030
$\frac{1}{8}$	1.3345	1.0062
$\frac{1}{4}$	1.3361	1.0129
$\frac{1}{2}$	1.3393	1.0260
1	1.3460	1.0516
2	1.3579	1.1035
4	1.3800	1.2003

211. $\text{K}_2\text{C}_4\text{H}_4\text{O}_6$, Tartrate
 $t = 18^\circ\text{C}$ (47)

$\frac{1}{16}$	1.3341	1.0044
$\frac{1}{8}$	1.3350	1.0090
$\frac{1}{4}$	1.3372	1.0179
$\frac{1}{2}$	1.3408	1.0359
1	1.3485	1.0707
2	1.3625	1.1379
4	1.3913	1.2665

212. $\text{K}_3\text{C}_6\text{H}_5\text{O}_7$, Citrate
 $t = 16.5^\circ\text{C}$ (47)

$\frac{1}{16}$	1.3340	1.0041
$\frac{1}{8}$	1.3350	1.0082
$\frac{1}{4}$	1.3370	1.0166
$\frac{1}{2}$	1.3410	1.0331
1	1.3478	1.0650
2	1.3618	1.1293
4	1.3867	1.2452

213. $\text{K}(\text{CH}_3\text{SO}_4)$, Methylsul-
 fate (35); best commercial
 material

M_B/M_A	$n_D^{13.5}$	$d_4^{13.5}$
9.86	1.36905	1.2914

214. $\text{K}(\text{C}_2\text{H}_5\text{SO}_4)$, Ethylsul-
 fate (35); best commercial
 material

M_B/M_A	n_D^t	d_4^t	t
14.50	1.36632*	1.2033	12
12.17	1.36960	1.2315	14
12.17	1.37024	1.2315	13

* Recrystallized from $\text{C}_2\text{H}_5\text{OH}$;
 air-dried.

214.1 $\text{KC}_6\text{H}_5\text{O}_3\text{S}$, Benzenesul-
 fonate; see 280

215. KCN (113); see also 574,
 576, 585

g B/l soln., 25°	n_D^{25}	d_4^{25}
13.036	1.33386	1.00350
13.038	1.33386	1.00346
65.19	1.34039	1.03153

215.1. $\text{KC}_6\text{H}_4\text{NO}_3$, *o*-Nitrophe-
 nolate; see 272

215.2. $\text{KC}_6\text{H}_4\text{NO}_3$, *m*-Nitrophe-
 nolate; see 273

215.3. $\text{KC}_6\text{H}_4\text{NO}_3$, *p*-Nitrophe-
 nolate; see 274

215.4. $\text{KC}_6\text{H}_3\text{N}_2\text{O}_5$, 2, 3-Dinitro-
 phenolate; see 267

215.5. $\text{KC}_6\text{H}_3\text{N}_2\text{O}_5$, 2, 4-Dinitro-
 phenolate; see 268

215.6. $\text{KC}_6\text{H}_3\text{N}_2\text{O}_5$, 2, 6-Dinitro-
 phenolate; see 269

215.7. $\text{KC}_6\text{H}_3\text{N}_2\text{O}_5$, 3, 4-Dinitro-
 phenolate; see 270

215.8. $\text{KC}_6\text{H}_3\text{N}_2\text{O}_5$, 3, 6-Dinitro-
 phenolate; see 271

215.9. $\text{KC}_7\text{H}_5\text{N}_2\text{O}_4$, *aei*-Phenyl-
 nitromethane; see 289

216. KCNS ; $t = 18^\circ\text{C}$ (64)

N_t	n_D^t
0.1	1.33508
0.2	1.33681
0.5	1.34204
1.0	1.35069
2.0	1.36780
4.0	1.40018

(Abbe-Zeiss) $t = 20^\circ\text{C}$ (14)

0.1	1.3349
1	1.3511
1	$n_D^{30} = 1.3502$

217. $\text{K}_3\text{Fe}(\text{CN})_6$; $t = 18^\circ\text{C}$ (86)

0.5	1.34211
1	1.35071
2	1.36730

218. $\text{K}_4\text{Fe}(\text{CN})_6$; $t = 18^\circ\text{C}$ (86)

0.5	1.34253
1	1.35143
2	1.36874

219. K_2CrO_4 ; $t = 18^\circ\text{C}$ (64)

0.1	1.33529
0.2	1.33732
0.5	1.34335
1.0	1.35305
2.0	1.37188
4.0	1.40709

$t = 18^\circ\text{C}$ (86)

0.3	1.33929
0.5	1.34332
1	1.35305
2	1.37181
4	1.40661

(Abbe-Zeiss) $t = 20^\circ\text{C}$ (14)

0.1	1.3350
1	1.3521
1	$n_D^{30} = 1.3512$

220. $\text{K}_2\text{Cr}_2\text{O}_7$; $t = 18^\circ\text{C}$ (86)

0.3	1.34107
0.5	1.34628

221. RbCl ; $t = 18^\circ\text{C}$ (64)

0.1	1.33439
0.2	1.33550

221.—(Continued)

N_t	n_D^t
0.5	1.33873
1.0	1.34398
2.0	1.35383
4.0	1.37265

For 1N; $n_D^{20} = 1.34337$ (56).

222. RbBr ; $t = 18^\circ\text{C}$ (64)

0.1	1.33476
0.2	1.33624
0.5	1.34064
1.0	1.34784
2.0	1.36177
4.0	1.38840

223. RbI ; $t = 18^\circ\text{C}$ (64)

0.2	1.33771
0.5	1.34450
1.0	1.35538
2.0	1.37721
4.0	1.41904

224. Rb_2SO_4 ; $t = 18^\circ\text{C}$ (64)

0.1	1.33453
0.2	1.33575
0.5	1.33925
1.0	1.34472
2.0	1.35482
3.0	1.36377

225. RbNO_3 ; $t = 18^\circ\text{C}$ (64)

0.1	1.33435
0.2	1.33542
0.5	1.33855
1.0	1.34360
2.0	1.35308
3.0	1.36216

$t = 20^\circ\text{C}$ (56)

0.5	1.33785
1.0	1.34268

226. CsCl ; $t = 18^\circ\text{C}$ (64)

0.5	1.33986
1.0	1.34623
2.0	1.35853
4.0	1.38187

For 1N, $n_D^{20} = 1.34571$ (56).

227. CsBr ; $t = 18^\circ\text{C}$ (86)

0.5	1.34194
1	1.35042
2	1.36717
4	1.39909

228. CsNO_3 ; $t = 18^\circ\text{C}$ (86)

0.3	1.33707
0.5	1.33953
1	1.34547

$t = 20^\circ\text{C}$ (56)

0.5	1.33902
1.0	1.34492

228.1. Gelatin (83); 3.2% B

t	n_D^t	d_4^t
20	1.33749	1.006
30	1.33616	1.005
40	1.33488	1.003
50	1.33410	1.002
60	1.33298	1.000

Proteins; see Table 4

Non-Aqueous Two-Component Systems—Inorganic

S	
229. B = Se (88)	
Room temp.	
% B	n_D
0.0	1.998
9.0	2.022
17.6	2.050
25.0	2.078
31.8	2.107
37.5	2.134
43.2	2.163
48.2	2.193
53.0	2.220
57.0	2.248
64.0	2.307
70.0	2.365
75.0	2.423
80.0	2.490
87.7	2.624
93.8	2.755

229.—(Continued)	
% B	n_D
99.2	2.90
100	2.92
NaCl	
230. B = KCl (96)	
(Abbe) $t = 18.0 \pm 0.1^\circ\text{C}$	
% A	n_D^{18}
0	1.4903
10	1.4955
20	1.5006
30	1.5048
40	1.5093
50	1.5145
60	1.5205
70	1.5258
80	1.5316
90	1.5382
100	1.5443

Non-Aqueous Two-Component Systems

The A-Component is a C-Compound

C-Arrangement, *v.* Vol. III, p. viii

All carbon compounds containing no element of key-number greater than 16 are here indexed as A-components. For others, see Section I.

CCl₄

Carbon tetrachloride; *cf.* (130)
231. B = C₂H₄Br₂, Ethylene
bromide; $t = 25^\circ\text{C}$ (129)

% A	n_D^t
0.00	1.5363
10.62	1.5261
20.27	1.5161
29.86	1.5076
39.85	1.4989
49.90	1.4909
60.02	1.4832
70.64	1.4763
80.02	1.4694
90.13	1.4634

232. B = C₂H₄O₂, Acetic acid
(137)

t	n_D^t	$d_4^{t'}$	t'
21.319% A			
13.0	1.38524	1.13292	14.6
24.5	1.38050	1.12456	21.1
40.3	1.37340	1.11416	29.2
41.728% A			
13.3	1.39829	1.22167	14.2
39.5	1.38572	1.21144	21.3
57.0	1.37708	1.19884	29.3
64.436% A			
14.5	1.41676	1.33894	16.4
22.5	1.41277	1.32430	24.2
34.1	1.40660	1.31563	30.4

232.—(Continued)			
t	n_D^t	$d_4^{t'}$	t'
100.000% A			
10.7	1.46563	1.60012	17.0
23.8	1.45786	1.58622	24.1
37.1	1.44989	1.57358	30.5
233. B = C ₂ H ₅ I, Ethyl iodide;			
$t = 25.2^\circ\text{C}$ (152)			
% B	n_D^t		
0.00	1.45707		
12.78	1.46385		
21.16	1.46782		
29.35	1.47102		
40.29	1.47755		
49.35	1.48239		
60.77	1.48858		
70.15	1.49375		
80.03	1.49901		
90.23	1.50469		
100.00	1.51009		

234. B = C₄H₈O₂, Ethyl acetate; $t = 25.2^\circ\text{C}$ (152)

% B	n_D^t
0.00	1.45707
9.74	1.44305
20.10	1.43026
29.81	1.41936
39.99	1.40948
59.68	1.39362
69.44	1.38698
79.45	1.38082
89.98	1.37524
100.00	1.37012

235. B = C₆H₆, Benzene

% A	n_D^t
$t = 18^\circ\text{C}$ (80)	
0	1.5024
10	1.5008
20	1.4985
30	1.4958
40	1.4929
50	1.4894
60	1.4853
70	1.4807
80	1.4755
90	1.4692
100	1.4618
$t = 25^\circ\text{C}$ (70)	
0.000	1.49794
16.873	1.49420
31.954	1.49030
43.419	1.48674
55.495	1.48232
64.704	1.47849
71.042	1.47555
79.671	1.47109
87.639	1.46629
93.504	1.46230
100.000	1.45732

236. B = C₇H₈, Toluene

$t = 18^\circ\text{C}$ (80)	
0	1.4970
10	1.4965
20	1.4937
30	1.4914
40	1.4889
50	1.4860
60	1.4827
70	1.4787
80	1.4742
90	1.4685
100	1.4618
$t = 25^\circ\text{C}$ (129)	
0.00	1.4929
9.66	1.4912
20.00	1.4891
31.21	1.4869
39.88	1.4849
49.88	1.4817
60.29	1.4785
69.94	1.4743
80.04	1.4698
89.89	1.4641
100.00	1.4575

See also 586.

CS₂Carbon disulfide; *cf.* (42, 154)

237. B = SnCl ₄ , Stannic chloride (135)			
<i>t</i>	<i>n</i> ₅₈₇₆ ^{<i>t</i>}	<i>d</i> ₄ ^{<i>t'</i>}	<i>t'</i>
0.00% B			
19.1	1.62783	1.26037	21.2
28.3	1.62070	1.24069	34.2
13.8282% B			
25.7	1.61160	1.33067	25.9
34.1	1.60476	1.31700	34.5

237.—(Continued)

t	n_D^t	$d_4^{t'}$	t'
27.2410% B			
24.9	1.59953	1.41697	25.2
34.1	1.59259	1.40184	34.2
38.6050% B			
23.7	1.58898	1.50003	24.5
34.1	1.58092	1.48290	34.3
44.3085% B			
24.2	1.58234	1.54270	25.9
36.1	1.57346	1.52696	34.4
66.3864% B			
26.2	1.55535	1.74819	26.5
35.5	1.54852	1.73114	34.6
80.7152% B			
25.1	1.53690	1.91772	25.1
37.4	1.52862	1.89828	34.5
100.00% B			
27.1	1.50751	2.21355	23.3
42.7	1.49795	2.12436	58.0

238. B = CHCl₃, Chloroform
(135)

t	n_D^t	$d_4^{t'}$	t'
0.000% B			
19.1	1.62783	1.26037	21.0
28.3	1.62070	1.24069	34.2
19.1533% B			
27.8	1.58706	1.27966	29.1
35.7	1.58148	1.27344	33.9
34.8063% B			
26.6	1.55971	1.31066	27.7
33.1	1.55457	1.30240	33.0
50.6210% B			
26.1	1.53157	1.34150	27.7
36.4	1.52391	1.33358	33.8
58.9405% B			
26.0	1.51669	1.35928	27.8
36.5	1.50874	1.34857	33.9
75.7576% B			
28.5	1.48382	1.39727	29.0
33.8	1.47992	1.38919	33.3
100.000% B			
22.7	1.44320	1.47571	22.0
35.4	1.43548	1.44307	39.5

239. B = C₂H₄O₂, Acetic acid
(133, 136)

t	n_D^t	$d_4^{t'}$	t'
0.000% B			
6.8	1.63816	1.27348	13.4
20.9	1.62694	1.25983	22.6
34.5	1.61588	1.24283	33.9
12.076% B			
11.9	1.58723	1.22831	13.5
23.1	1.57854	1.21786	20.6
44.3	1.56172	1.20261	30.8
61.284% B			
13.9	1.44695	1.10562	14.7
21.1	1.44281	1.09475	22.7
35.0	1.43461	1.08355	30.7
80.298% B			
11.5	1.40855	1.07807	13.0
23.0	1.40300	1.06871	20.7
41.2	1.39424	1.05643	30.1

CS₂.—(Continued)

239.—(Continued)

<i>t</i>	<i>n</i> _D ^{<i>t</i>}	<i>d</i> ₄ ^{<i>t</i>}	<i>t</i> '
100.000% B			
21.2	1.37146	1.05819	12.5
31.7	1.36738	1.04546	23.9
49.7	1.36014	1.03897	30.4

240. B = C₂H₅NO₃, Ethyl nitrate (105)

% B	<i>n</i> _F ¹⁵	<i>d</i> ₄ ^{<i>t</i>}	<i>t</i> '
0.00	1.65513	1.26839	16.8
46.73	1.51012	1.17388	15.0

241. B = C₂H₆O, Ethyl alcohol; *t* = 20°C (134)

% B	<i>n</i> _F ^{<i>t</i>}	<i>d</i> ₄ ^{<i>t</i>}
0.000	1.65268	1.26354
20.182	1.56279	1.12167
31.966	1.52081	1.05425
49.234	1.47039	0.97177
100.000	1.36676	0.79628

242. B = C₃H₆O, Acetone (70, 71); cf. (152)

% A	<i>n</i> _D ⁵²
0.000	1.35645
13.245	1.37576
29.326	1.40364
40.329	1.42567
51.761	1.45253
51.799	1.45253
51.902	1.45271
71.137	1.50692
83.283	1.55043
86.892	1.56465
100.000	1.62357

243. B = C₃H₅O₂, Methylal
t = 25°C (70, 71)

0.000	1.35018
12.921	1.37164
28.682	1.40178
38.408	1.42294
45.630	1.44005
53.139	1.45922
60.034	1.47810
62.38	1.48497
65.262	1.49357
75.141	1.52508
86.449	1.56665
100.000	1.62357

t = 25.4°C (152); cf. (82)

0.00	1.35064
10.14	1.36739
20.24	1.38556
30.45	1.40622
40.45	1.42831
50.28	1.45247
60.06	1.47892
69.75	1.50863
80.00	1.54264
89.73	1.57937
94.25	1.59829
100.00	1.62341

244. B = C₄H₈O₂, Isobutyric acid (133, 136)

<i>t</i>	<i>n</i> _D ^{<i>t</i>}	<i>d</i> ₄ ^{<i>t</i>}	<i>t</i> '
0.000% B			
6.8	1.63816	1.27348	13.4
20.9	1.62694	1.25983	22.6
34.5	1.61588	1.24283	33.9
20.336% B			
11.75	1.56445	1.18353	13.3
19.5	1.55908	1.17067	22.7
34.5	1.54810	1.15993	30.1
45.276% B			
11.2	1.49687	1.09615	12.4
18.2	1.49253	1.08550	21.1
30.8	1.48470	1.07236	31.0
68.028% B			
13.2	1.44813	1.03144	13.1
18.4	1.44515	1.02316	20.4
38.0	1.43480	1.01398	28.2
100.000% B			
9.1	1.39689	0.96211	11.4
25.9	1.38973	0.93921	34.2
39.4	1.38394	0.91978	53.2
68.4	1.37145	0.89795	74.4

245. B = C₄H₁₀O, Isobutyl alcohol (133, 136)

15.803% B			
9.6	1.57631	1.16304	11.3
28.9	1.56198	1.15392	18.7
39.7	1.55357	1.13648	31.7
30.008% B			
8.3	1.53380	1.07702	13.9
25.2	1.52266	1.06903	21.1
33.6	1.51664	1.05245	34.2
50.220% B			
11.8	1.48276	0.97919	15.5
22.1	1.47679	0.96248	30.7
70.388% B			
9.5	1.44470	0.90118	13.8
22.4	1.43825	0.88336	32.4
100.000% B			
23.7	1.39372	0.80680	16.2
34.9	1.38912	0.79423	31.8

246. B = C₄H₁₀O, Ethyl ether (135)

<i>t</i>	<i>n</i> _D ^{58.76}	<i>d</i> ₄ ^{<i>t</i>}	<i>t</i> '
0.000% B			
19.1	1.62783	1.26037	21.0
28.3	1.62070	1.24069	34.2
20.3505% B			
24.0	1.53524	1.08508	24.2
30.2	1.53084	1.07455	31.5
29.6571% B			
25.4	1.50187	1.02038	25.0
30.3	1.49773	1.01067	31.8
41.5400% B			
24.4	1.46729	0.95077	23.7
30.3	1.46336	0.94204	30.0
59.9864% B			
25.3	1.42070	0.85919	23.0
30.6	1.41679	0.84799	31.6
79.7398% B			
25.7	1.38123	0.77530	25.5
100.000% B			
24.8	1.34974	0.70920	23.7
29.7	1.34665	0.69894	32.3

247. B = C₅H₁₀O₂, Isovaleric acid (133, 136)

<i>t</i>	<i>n</i> _D ^{<i>t</i>}	<i>d</i> ₄ ^{<i>t</i>}	<i>t</i> '
28.295% B			
9.5	1.54626	1.14718	12.1
20.3	1.53891	1.13613	20.7
32.0	1.53095	1.12267	30.7
45.900% B			
8.0	1.50346	1.08096	14.2
19.8	1.49639	1.07130	22.3
26.6	1.49213	1.06044	31.2
62.573% B			
11.2	1.46666	1.03281	10.2
20.5	1.46158	1.02326	19.7
37.7	1.45234	1.01100	30.7
100.000% B			
8.1	1.40736		
28.3	1.39888	0.93319	17.6
41.9	1.39322	0.91204	40.2
57.0	1.38694	0.89222	60.8

CHBr₃

Bromoform

248. B = CHCl₃, Chloroform (51)

% B	<i>n</i> _D ²⁵
0.00	1.58794
7.88	1.57086
20.87	1.54356
23.47	1.53988
24.34	1.53690
38.92	1.51184
54.12	1.49001
78.11	1.46360
100.00	1.44260

CHCl₃

Chloroform; cf. (42, 75)

249. B = C₂H₄O₂, Acetic acid (137)

<i>t</i>	<i>n</i> _D ^{<i>t</i>}	<i>d</i> ₄ ^{<i>t</i>}	<i>t</i> '
27.584% A			
12.9	1.38763	1.14511	14.5
22.0	1.38411	1.13496	22.3
39.4	1.37635	1.12221	32.0
50.994% A			
12.1	1.40315	1.23599	14.5
22.8	1.39811	1.22515	21.9
39.2	1.39015	1.21275	30.0
68.619% A			
13.0	1.41733	1.31752	14.7
24.0	1.41157	1.30404	23.1
43.9	1.40068	1.29206	30.3
80.763% A			
10.0	1.43019	1.38688	11.7
21.6	1.42373	1.37281	20.0
41.8	1.41225	1.35469	30.4

250. B = C₂H₆O, Ethyl alcohol (137)

0.000% A			
10.8	1.36501	0.79693	11.3
18.7	1.36185	0.78884	21.0
47.5	1.34984	0.78152	29.3

250.—(Continued)

<i>t</i>	<i>n</i> _D ^{<i>t</i>}	<i>d</i> ₄ ^{<i>t</i>}	<i>t</i> '
19.522% A			
8.7	1.37626	0.87860	11.7
24.9	1.36944	0.86882	22.0
30.2	1.36711	0.86055	30.6
27.661% A			
10.0	1.38036	0.91587	11.3
25.0	1.37367	0.90777	19.7
33.0	1.37028	0.89725	29.8
34.824% A			
6.2	1.38714	0.95644	10.7
17.3	1.38211	0.94825	18.7
36.6	1.37331	0.93548	30.3
49.079% A			
11.0	1.39537	1.04136	10.2
22.4	1.39002	1.02775	21.9
35.8	1.38351	1.01505	32.0
60.901% A			
10.5	1.40539	1.11711	14.5
24.2	1.39849	1.10569	23.1
31.3	1.39486	1.09548	30.5
78.429% A			
7.3	1.42431	1.26612	10.9
17.4	1.41877	1.25308	19.4
36.5	1.40795	1.23663	29.7
87.414% A			
11.8	1.43251	1.35474	10.9
24.0	1.42556	1.33693	21.7
37.5	1.41754	1.32113	30.7

251. B = C₃H₆O, Acetone (137); cf. (70, 152)

0.000% A			
9.6	1.36436	0.7991	13.4
20.4	1.35874	0.7928	19.2
37.4	1.34962	0.7850	26.0
22.396% A			
10.6	1.37533	0.89393	11.7
24.4	1.36803	0.88351	20.5
36.0	1.36171	0.87181	30.0
41.577% A			
11.7	1.38724	0.99346	11.8
28.0	1.37847	0.97933	23.0
36.2	1.37399	0.96852	30.1
56.889% A			
10.2	1.40037	1.09070	12.0
21.0	1.39460	1.07611	22.4
36.5	1.38609	1.06194	31.6
84.064% A			
12.4	1.42835	1.32149	11.8
20.0	1.42388	1.30576	21.5
36.3	1.41456	1.28932	31.1
93.901% A			
12.2	1.44168	1.42861	12.2
19.0	1.43788	1.41283	21.2
31.2	1.43034	1.39038	33.4

251.—(Continued)
(70); cf. (71, 152)

% A	n_D^{25}
0.00	1.35621
16.664	1.36454
33.039	1.37417
45.832	1.38332
56.298	1.39196
64.507	1.39943
72.276	1.40757
79.884	1.41618
88.409	1.42692
94.292	1.43487
100.000	1.44309

See also 238, 248.

CH₂I₂

Methylene iodide

252. B = C₆H₁₀O₄, Diethyl oxalate (105)

% A	n_D^{15}	d_4^{15}
0.00	1.41781	1.08547
75.50	1.57322	2.18438
100.00	1.77266	3.3398

CH₂O

Formaldehyde; see 20

CH₂O₂

Formic acid

253. B = C₁₀H₁₆O, Camphor (53)

% B	n_D^{20}	d_4^{20}
0.00	1.3709	1.2201
8.44	1.3794	1.1881
17.27	1.3891	1.1579
26.56	1.3971	1.1313
36.31	1.4063	1.1026
46.54	1.4175	1.0746

If % B < 50, a = 1.3709,
b = 0.9775, $\epsilon = 1$ or 2.CH₄N₂S

Ammonium thiocyanate; see 21

CH₄O

Methyl alcohol

254. B = CdI₂, Cadmium iodide; $t = 20.5^\circ\text{C}$ (48)

% B	n_D^t	d_4^t
0.000	1.32875	0.7942
0.012	1.32887	0.7942
0.115	1.32887	0.7943
0.460	1.32932	0.7969
1.150	1.33016	0.8021
2.301	1.33159	0.8099
4.602	1.33452	0.8269
11.555	1.34300	0.8766

If % B < 11.6, a = 1.32875,
b = 1.235, c = 0, $\epsilon = 1$.255. B = C₂H₃NaO₂, Sodium acetate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33279	0.8134

256. B = C₂H₄O₂, Acetic acid; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
0	1.32663	0.7894
5	1.32978	0.8021

257. B = C₂H₆O, Ethyl alcohol; $t = 15^\circ\text{C}$ (36)

% B	n_D^t
0.00	1.33057
10.63	1.33390
21.22	1.33740
32.03	1.34115
41.21	1.34422
49.84	1.34697
61.08	1.35070
74.895	1.35517
81.31	1.35718
90.10	1.36010
100.00	1.36330

100n = $n_A(\% A) + n_B(\% B)$;
 $\epsilon = 1$ or 2.258. B = C₃H₆NaO₂, Sodium propionate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33415	0.8146

259. B = C₃H₆O₂, Propionic acid; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33176	0.8036

260. B = C₃H₈O, *n*-Propyl alcohol; $t = 15^\circ\text{C}$ (36)

% B	n_D^t
0.00	1.33053
4.37	1.33312
9.88	1.33603
34.63	1.35002
40.90	1.35394
59.62	1.36423
68.12	1.36900
78.94	1.37518
88.035	1.38036
100.00	1.38726

100n = $n_A(\% A) + n_B(\% B)$;
 $\epsilon = 1$ or 2.261. B = C₄H₇NaO₂, Sodium butyrate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33540	0.8156

262. B = C₄H₈O₂, Butyric acid; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33350	0.8050

263. B = C₄H₁₀O, Isobutyl alcohol; $t = 15^\circ\text{C}$ (36)

% B	n_D^t
0.00	1.33053
5.34	1.33484
14.19	1.34055
22.545	1.34620
39.47	1.35710
49.415	1.36372
89.84	1.39102
100.00	1.39750

n is not quite linear in % B.

264. B = C₅H₅N, Pyridine; $t = 17.5^\circ\text{C}$ (147)

g B/l soln.	n_D^t
0.00	1.32979
7.98	1.33130
15.96	1.33285
59.80	1.34124
119.59	1.35257

If g B/l soln. < 120, $n_D^{17.5} = \{1.32979 + 0.00019(\text{g B/l soln.})\} \pm 0.0001$.265. B = C₅H₉NaO₂, Sodium valerate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33508	0.8160

266. B = C₅H₁₀O₂, Valeric acid; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33500	0.8066

267. B = C₆H₃KN₂O₅, 2, 3-Dinitrophenolate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33251	0.8106

268. B = C₆H₃KN₂O₅, 2, 4-Dinitrophenolate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33375	0.8112

269. B = C₆H₃KN₂O₅, 2, 6-Dinitrophenolate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33395	0.8115

270. B = C₆H₃KN₂O₅, 3, 4-Dinitrophenolate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33242	0.8105

271. B = C₆H₃KN₂O₅, 3, 6-Dinitrophenolate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33240	0.8104

272. B = C₆H₄KNO₃, *o*-Nitrophenolate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
2.5	1.32654	0.7909

273. B = C₆H₄KNO₃, *m*-Nitrophenolate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
2.5	1.32335	0.7900

274. B = C₆H₄KNO₃, *p*-Nitrophenolate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
2.5	1.32910	0.7940

275. B = C₆H₄N₂O₅, 2, 3-Dinitrophenol; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33234	0.8050

276. B = C₆H₄N₂O₅, 2, 4-Dinitrophenol; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33270	0.8056

277. B = C₆H₄N₂O₅, 2, 6-Dinitrophenol; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33290	0.8058

278. B = C₆H₄N₂O₅, 3, 4-Dinitrophenol; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33217	0.8048

279. B = C₆H₄N₂O₅, 3, 6-Dinitrophenol; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33231	0.8049

280. B = C₆H₅KO₃S, Benzene-sulfonate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.32689	0.8015

281. B = C₆H₅NO₃, *o*-Nitrophenol; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33020	0.7951

282. B = C₆H₅NO₃, *m*-Nitrophenol; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.32850	0.7957

283. B = C₆H₅NO₃, *p*-Nitrophenol; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.32880	0.8006

284. B = C₆H₆, Benzene; $t = 17.5^\circ\text{C}$ (147)

g B/l soln.	n_D^t
0.00	1.32979
4.07	1.33057
8.13	1.33133
15.01	1.33266
30.03	1.33549
49.58	1.33924
105.72	1.34988
156.60	1.35961

If g B/l soln. < 40, $n_D^{17.5} = \{1.32979 + 0.000285(\text{g B/l soln.})\} \pm 0.0001$.285. B = C₆H₅O₃S, Benzene-sulfonic acid; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.32989	0.8002

286. B = C₇H₄NNaO₄, *o*-Nitrobenzoate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33510	0.8189

287. B = C₇H₄NNaO₄, *m*-Nitrobenzoate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33479	0.8188

288. B = C₇H₄NNaO₄, *p*-Nitrobenzoate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33528	0.8189

289. B = C₇H₅KN₂O₄, *aci-o*-Nitrophenylnitromethane; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
2.5	1.32842	0.7990

290. B = C₇H₅NO₄, *o*-Nitrobenzoic acid; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33290	0.8120

291. B = C₇H₅NO₄, *m*-Nitrobenzoic acid; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33290	0.8118

292. B = C₇H₅NO₄, *p*-Nitrobenzoic acid; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33291	0.8120

293. B = C₇H₅N₂NaO₄, *aci-p*-Nitrophenylnitromethane; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
2.5	1.32870	0.7987

294. B = C₇H₆NaO₂, Benzoate; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
5	1.33466	0.8160

295. B = C₇H₅N₂O₄, *aci-o*-Nitrophenylnitromethane; $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
2.5	1.32811	0.7962

CH₄O.—(Continued)

296. B = C₇H₆N₂O₄, *aci-p*-Nitrophenylnitromethane;
 $t = 25^\circ\text{C}$ (84)

% B	n_D^t	d_4^t
2.5	1.32802	0.7960

297. B = C₇H₆O₂, Benzoic acid; $t = 25^\circ\text{C}$ (84)

5	1.33369	0.8100
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298. B = C₉H₇N, Quinoline;
 $t = 17.5^\circ\text{C}$ (147)

g B/l soln.	n_D^t
0.00	1.32979
19.82	1.33549
39.64	1.34111

If g B/l soln. < 40, $n = \{1.32979 + 0.000285(\text{g B/l soln.})\} \pm 0.0001$.

299. B = C₁₀H₈, Naphthalene;
 $t = 17.5^\circ\text{C}$ (147)

% B	n_D^t
0.00	1.32979
1.07	1.33208
1.99	1.33435
3.91	1.33888

If % B < 4, $n = \{1.32979 + 0.00232(\% \text{ B})\} \pm 0.0001$.

300. B = C₁₀H₁₆O, Camphor;
 $t = 20^\circ\text{C}$ (53)

% B	n_D^t	d_4^t
0.00	1.3290	0.7912
12.34	1.3435	0.8102
24.14	1.3576	0.8286
35.46	1.3723	0.8472
46.26	1.3876	0.8649
56.66	1.4026	0.8827

If % B < 50, $a = 1.3290$, $b = 1.112$, $c = 3.24$, $e = 2$ or 3.

301. B = C₁₂H₁₀, Diphenyl;
 $t = 17.5^\circ\text{C}$ (147)

% B	n_D^t
0.00	1.32979
0.355	1.33062
1.40	1.33296
1.71	1.33370
2.76	1.33603
3.24	1.33743
6.50	1.34485

If % B < 6.5, $a = 1.32979$, $b = 2.32$, $e = 0$, $e = 1$.

302. B = C₁₉H₁₆, Triphenylmethane; $t = 17.5^\circ\text{C}$ (147)

% B	n_D^t
0.00	1.32979
0.543	1.33097
0.717	1.33135
1.42	1.33293

If % B < 1.5, $a = 1.32979$, $b = 2.21$, $e = 0$, $e = 1$.

See also 22, 552.

C₂HCl₃O₂

Trichloroacetic acid; see 23

C₂H₂O₄

Oxalic acid; see 24, 553

C₂H₄Br₂

Ethylene bromide; cf. (128)

303. B = C₃H₆Br₂, Propylene bromide; $t = 25.4^\circ\text{C}$ (152)

% B	n_D^t
0.00	1.53601
6.06	1.53466
19.74	1.53190
26.97	1.53048
32.10	1.52953
40.27	1.52797
51.64	1.52588
60.11	1.52430
69.72	1.52263
80.27	1.52081
90.64	1.51898
100.00	1.51745

304. B = C₇H₈, Toluene;
 $t = 25^\circ\text{C}$ (129)

% B	n_D^t
0.00	1.5363
10.00	1.5250
20.00	1.5170
30.00	1.5110
40.00	1.5065
50.00	1.5028
60.00	1.5000
70.00	1.4977
80.00	1.4960
90.00	1.4943
100.00	1.4929

305. B = C₁₀H₈, Naphthalene;
 $t = 17.4^\circ\text{C}$ (76)

% B	n_D^t	d_4^t
0.000	1.53832	2.1639
9.629	1.55250	1.9540
14.407	1.55897	1.8655

See also 231, 586.

C₂H₄Cl₂

Ethylene chloride

306. B = C₂H₄O₂, Acetic acid (137)

t	n_D^t	$d_4^{t'}$	t'
	26.593 % A		
9.0	1.39018	1.10223	10.1
21.2	1.38488	1.09026	20.0
41.8	1.37589	1.07690	31.3
	46.948 % A		
9.7	1.40307	1.13834	11.4
20.2	1.39835	1.12615	20.9
37.2	1.39022	1.11395	30.3
	69.568 % A		
8.6	1.42113	1.18804	10.4
23.5	1.41370	1.17327	21.3
42.0	1.40431	1.16102	30.3
	88.390 % A		
9.0	1.43825	1.23438	10.7
28.5	1.42811	1.22088	20.2
52.3	1.41534	1.20640	30.2

307. B = C₃H₆O, Acetone (137)

t	n_D^t	$d_4^{t'}$	t'
	26.844 % A		
9.8	1.38058	0.88827	11.9
23.8	1.37294	0.87478	23.3
	51.575 % A		
7.8	1.39938	0.98873	11.2
20.3	1.39283	0.97591	21.4
	72.414 % A		
9.8	1.41774	1.09289	10.3
25.9	1.40894	1.07983	20.1
	86.874 % A		
12.1	1.43198	1.17482	12.5
23.3	1.42592	1.16078	22.6
	100.000 % A		
9.7	1.45031	1.25759	17.2
25.4	1.44178	1.24792	23.8
43.0	1.43210	1.23841	30.1

308. B = C₆H₆, Benzene (152)

% A	$n_D^{25.2}$
0.00	1.49779
10.16	1.49294
23.25	1.48641
30.30	1.48273
41.35	1.47696
49.40	1.47270
60.07	1.46687
60.44	1.46643
71.04	1.46041
78.81	1.45572
90.80	1.44842
100.00	1.44225

C₂H₄O

Acetaldehyde

309. B = C₂H₆O, Ethyl alcohol (78); cf. (134)

% A	n_D^{18}
0.00	1.3601
10.01	1.3660
20.99	1.3720
21.61	1.3727
30.58	1.3764
36.36	1.3784
42.01	1.3790
52.04	1.3775
61.56	1.3718
74.10	1.3614
81.10	1.3538
100.00	1.3392

C₂H₄O₂

Acetic acid; cf. (20, 155)

310. B = C₄H₉Br, Butyl bromide (137)

t	n_D^t	$d_4^{t'}$	t'
	21.961 % B		
14.1	1.38150	1.08095	14.4
24.4	1.37717	1.07000	23.5
44.4	1.36843	1.06157	30.3
	43.647 % B		
13.5	1.39173	1.11132	14.4
24.0	1.38693	1.10189	21.7
36.1	1.38118	1.08960	31.0

310.—(Continued)

t	n_D^t	$d_4^{t'}$	t'
	68.091 % B		
13.2	1.40554	1.15152	14.4
40.7	1.39116	1.12783	31.0
	100.000 % B		
10.4	1.43228	1.22678	10.8
26.0	1.42332	1.21142	20.5
58.8	1.40357	1.19534	30.2

311. B = C₅H₅N, Pyridine (152)

% A	$n_D^{25.2}$
0.00	1.50695
4.62	1.50170
10.21	1.49523
20.30	1.48399
30.40	1.47284
40.40	1.46235
50.05	1.45277
60.07	1.44335
70.24	1.43312
79.80	1.42051
90.35	1.39891
100.00	1.37015

312. B = C₆H₆, Benzene (70, 71); cf. (152)

% A	n_D^{25}
0.000	1.49794
11.634	1.48218
23.614	1.46628
34.008	1.45265
44.857	1.43861
54.459	1.42618
63.968	1.41418
73.819	1.40172
82.321	1.39119
91.338	1.38023
100.000	1.36976

313. B = C₆H₇N, Aniline (51)

% B	n_D^{25}
0.00	1.37070
11.87	1.40811
33.33	1.46261
38.65	1.47446
57.10	1.51066
65.54	1.52412
79.16	1.54916
93.31	1.53718
100.00	1.53118

314. B = C₇H₈, Toluene (152)

% A	$n_D^{25.2}$
0.00	1.49366
4.69	1.48785
9.20	1.48224
19.75	1.46910
29.75	1.45667
40.27	1.44360
49.90	1.43166
60.11	1.41921
69.94	1.40691
79.88	1.39469
89.84	1.38242
100.00	1.37003

315. B = C₁₀H₁₆O, Camphor (53)

% B	n_D^{20}	d_4^{20}
0.00	1.3713	1.0495
9.64	1.3811	1.0397
19.40	1.3913	1.0308
29.45	1.4010	1.0211
39.56	1.4115	1.0115
49.89	1.4221	1.0022

If % B < 50, a = 1.3713, b = 1.018, c = 1 or 2.

See also 25, 232, 239, 249, 256, 306, 554.

C₂H₄O₃

Glycolic acid; see 26, 555

C₂H₅Br

Ethyl bromide

316. B = C₃H₆O, Acetone (137)

t	n_D^t	d_4^t	t'
0.000% A			
9.6	1.36436	0.79279	19.2
20.4	1.35874	0.78499	26.0
33.110% A			
16.9	1.37269	0.93226	18.3
28.7	1.36610	0.91795	28.7
50.812% A			
16.3	1.38202	1.02784	19.2
28.3	1.37507	1.01465	28.0
67.809% A			
16.8	1.39290	1.14969	14.9
24.7	1.38845	1.12158	29.8
100.000% A			
16.0	1.42577	1.45543	20.9
32.1	1.41556	1.44561	25.6

C₂H₅BrO

Ethylenebromohydrin; see 27

C₂H₅ClO

Ethylenechlorohydrin (54)

C₂H₅I

Ethyl iodide

317. B = C₄H₈O₂, Ethyl acetate (70, 71); cf. (152)

% A	n_D^{25}
0.000	1.37005
19.082	1.38150
35.007	1.39393
49.517	1.40822
59.741	1.42090
68.529	1.43402
74.566	1.44447
82.792	1.46121
89.093	1.47646
94.970	1.49318
100.000	1.50992

See also 233.

C₂H₅NO₃

Ethyl nitrate

318. B = C₇H₁₆, Heptane (105)

% B	n_D^{15}	d_4^{15}	t'
0.00	1.38509*	1.11315	16.2
38.16	1.38442	0.89599	15.0
100.00	1.38855		

* At 16.2°C.

319. B = C₁₀H₇Br, α -Bromonaphthalene (105)

59.99	1.51739	1.30677	15
100.00	1.65186	1.49340	15

See also 240.

C₂H₆O

Ethyl alcohol; cf. (50, 63, 68, 75, 131)

320. B = CdI₂, Cadmium iodide (48)

% B	$n_D^{20.5}$	$d_4^{20.5}$
0.000	1.36104	0.7891
0.116	1.36117	0.7900
0.232	1.36136	0.7911
0.464	1.36148	0.7924
1.160	1.36219	0.7973
2.321	1.36355	0.8052
4.641	1.36559	0.8210
5.802	1.36695	0.8292
11.613	1.37289	0.8688
23.206	1.38517	0.9484
46.412	1.40964	1.1068

321. B = C₃H₈O, n -Propyl alcohol; $t = 25^\circ\text{C}$ (99, 100)

% A	n_D^t
0.00	1.3833
12.54	1.3803
25.00	1.3772
37.49	1.3742
50.02	1.3712
62.40	1.3681
74.93	1.3649
87.50	1.3619
100.00	1.3590

$100n = n_A(\% A) + n_B(\% B)$,

$\epsilon = 1$ or 2.

For A, $d_4^{25} = 0.78516$ (=99.97% C₂H₆O).

For B, $d_4^{25} = 0.8004$ (=99.35% C₃H₈O).

322. B = C₃H₈O, Isopropyl alcohol; $t = 25^\circ\text{C}$ (99, 100)

0.00	1.3750
17.23	1.3721
33.60	1.3697
49.87	1.3673
66.89	1.3646
83.61	1.3622
100.00	1.3595

$100n = n_A(\% A) + n_B(\% B)$,

$\epsilon = 1$ or 2.

For A, $d_4^{25} = 0.78516$ (=99.97% C₂H₆O).

For B, $d_4^{25} = 0.78086$ (=99.99% C₃H₈O).

323. B = C₄H₁₀O, Isobutyl alcohol; $t = 15^\circ\text{C}$ (36)

% A	n_D^t
0.00	1.39750
31.46	1.38644
40.91	1.38312
50.51	1.37995
70.94	1.37295
87.66	1.36734
93.695	1.36542
100.00	1.36330

n is not quite linear in % B.

324. B = C₆H₆, Benzene; $t = 18^\circ\text{C}$ (80)

0	1.5024
10	1.4869
20	1.4716
30	1.4568
40	1.4425
50	1.4283
60	1.4146
70	1.4011
80	1.3878
90	1.3749
100	1.3622

325. B = C₆H₇N, Aniline (95)

% B	n_D^{25}
0.00	1.3596
9.81	1.3782
20.49	1.3993
29.71	1.4183
36.37	1.4317
50.88	1.4630
59.61	1.4830
71.46	1.5110
80.99	1.5343
88.73	1.5531
100.00	1.5842

326. B = C₆H₈O₂, Cyclohexan-1, 4-dione (26)

% B	n_D^t	d_4^t	t
0.00	1.36097	0.79252	16.8
7.55	1.36792	0.81303	17.5
8.08	1.36853	0.81466	17.4

327. B = C₇H₈, Toluene; $t = 18^\circ\text{C}$ (80)

% A	n_D^t
0	1.4970
10	1.4823
20	1.4680
30	1.4539
40	1.4401
50	1.4265
60	1.4131
70	1.4000
80	1.3873
90	1.3747
100	1.3622

328. B = C₉H₆Br₂O₂, Dibromocinnamic acid; $t = 25^\circ\text{C}$ (151)

% B	n_D^{25}	d_4^{25}
0.000	1.35954	0.7851
5.205	1.36603	0.8107

329. B = C₉H₇BrO₂, α -Bromocinnamic acid; $t = 25^\circ\text{C}$ (151)

% B	n_D^{25}	d_4^{25}
0.000	1.35967	0.7851
4.677	1.36691	0.8053
5.041	1.36742	0.8069
5.192	1.36780	0.8076

330. B = C₉H₇BrO₂, β -Bromocinnamic acid; $t = 25^\circ\text{C}$ (151)

0.000	1.35954	0.7851
4.512	1.36623	0.8045
4.877	1.36681	0.8062

331. B = C₉H₇BrO₂, α -Bromallocinnamic acid; $t = 25^\circ\text{C}$ (151)

0.000	1.35967	0.7851
4.824	1.36681	0.8056
5.248	1.36747	0.8075
5.320	1.36757	0.8077

332. B = C₉H₇BrO₂, β -Bromallocinnamic acid; $t = 25^\circ\text{C}$ (151)

0.000	1.35954	0.7851
5.044	1.36649	0.8061

333. B = C₉H₇ClO₂, α -Chlorocinnamic acid; $t = 25^\circ\text{C}$ (151)

0.000	1.35967	0.7851
4.984	1.36851	0.8026
5.136	1.36879	0.8031
5.190	1.36893	0.8034
5.469	1.36930	0.8042

334. B = C₉H₇ClO₂, α -Chlorallocinnamic acid; $t = 25^\circ\text{C}$ (151)

0.000	1.35954	0.7851
5.008	1.36758	0.8021
5.051	1.36767	0.8024
5.260	1.36776	0.8024

335. B = C₁₀H₁₆BrO, Bromocamphor; $t = 25^\circ\text{C}$ (104)

% B	n_D^t	d_4^t
0.000	1.3602	0.7878
0.5078	1.3605	0.7892
4.978	1.3647	0.8040
9.765	1.3693	0.8213
14.320	1.3739	0.8379
18.730	1.3788	0.8549

If % B < 20, a = 1.3600, b = 0.92, c = 4; $\epsilon = 1$ or 2.

336. B = C₁₀H₁₆O, Camphor; $t = 20^\circ\text{C}$ (53)

0.00	1.3618	0.7939
12.32	1.3735	0.8129
24.10	1.3846	0.8304
35.57	1.3961	0.8478
46.25	1.4076	0.8649
56.79	1.4191	0.8822

If % B < 50, a = 1.3618, b = 0.902, c = 1.84; $\epsilon = 1$ or 2.

C₂H₆O.—(Continued)

336.—(Continued)

% B | n_D^{25} | d_4^{25}
 $t = 25^\circ\text{C} \text{ (}^{104}\text{)}$

0.000	1.3600	0.7874
0.7643	1.3606	0.7886
3.050	1.3629	0.7918
7.538	1.3673	0.7987
14.820	1.3736	0.8094
24.280	1.3832	0.8239
37.830	1.3971	0.8460
50.720	1.4108	0.8671

If % B < 50, $a = 1.3600$,
 $b = 0.9075$, $c = 1.85$; $\epsilon = 1$.

337. B = C₁₀H₁₈O, Borneol;
 $t = 25^\circ\text{C} \text{ (}^{103}\text{)}$

0.000	1.3602	0.7878
1.0162	1.3613	0.7889
2.736	1.3635	0.7921
3.586	1.3636	0.7934
5.290	1.3659	0.7944
7.541	1.3682	0.7998
9.967	1.3711	0.8040
24.330	1.3872	0.8278
35.070	1.3993	0.8466

If % B < 35, $a = 1.3602$,
 $b = 1.115$, $c = 0$; $\epsilon = 2$.

338. B = C₁₂H₁₂O₂, 2-Benzoyl-
cyclopentanone (⁹)

% B	n_D^{25}	d_4^{25}	t
0.000	1.36163	0.78534	25.0
4.520	1.37018	0.79784	25.0
6.454	1.37377	0.80310	25.2

339. B = C₁₃H₁₄O₂, 2-Benzoyl-
cyclohexanone (⁹)

0.000	1.36163	0.78534	25.0
2.567	1.36583	0.79246	24.8
2.835	1.36617	0.79314	24.8

340. B = C₁₆H₃₁KO₂, Palmitate (⁸⁴)

% B	n_D^{50}	d_0^{50}
2.5	1.35366	0.7552
5.0	1.35905	0.7560

341. B = C₁₆H₃₁NaO₂, Palmitate (⁸⁴)

2.5	1.35363	0.7547
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342. B = C₁₆H₃₂O₂, Palmitic
acid (⁸⁴)

0	1.34093	0.7490
5	1.36450	0.8100

343. B = C₁₃H₂₂N₂, Dibenzyl-
piperazine (²⁵)

% B	n_C^{18}	d_4^{18}
0.00	1.36138*	0.79982
6.43	1.37235	0.81305

* $t = 18.6^\circ\text{C}$.

344. B = C₁₈H₃₃NaO₂, Oleate
(⁸⁴)

% B	n_D^{50}	d_0^{50}
1.25	1.35490	0.7500
2.5	1.35862	0.7524

345. B = C₁₈H₃₄O₂, Oleic
acid (⁸⁴)

% B	n_D^{50}	d_0^{50}
0	1.34093	0.7490
5	1.36540	0.8114

346. B = C₁₈H₃₆O₂, Stearic
acid (⁸⁴)

0	1.34093	0.7490
5	1.36640	0.8133

347. B = C₁₉H₂₂N₂O, Cincho-
toxine (¹⁰³)

g B/l soln.	n_D^{26}	d_4^{26}
0.00	1.3602	0.7878
1.232	1.3607	0.7887
6.240	1.3617	0.7910
9.528	1.3630	0.7920
28.900	1.3667	0.7984
44.612	1.3695	0.8032
85.548	1.3796	0.8169
93.000	1.3800	0.8186

348. B = C₂₆H₂₆N₂O₂, Benzoyl-
cinchotoxine (¹⁰³)

0.000	1.3602	0.7878
9.704	1.3621	0.7911
21.028	1.3647	0.7954

See also 28, 241, 250, 257, 309,
556, 557, 558.

C₂H₆O₂

Glycol; see 29

C₂H₇NO₂

Ammonium acetate; see 30

C₂H₈N₂O₄

Ammonium oxalate; see 31

C₃H₆Br₂

Propylenc bromide; see 303

C₃H₆O

Acetone; cf. (³⁹)

349. B = C₃H₈O, Isopropyl
alcohol (⁹⁸)

% B	n_C^{22}
0.00	1.35633
1.38	1.35655
1.95	1.35651
2.41	1.35660
3.50	1.35701
5.07	1.35714
8.24	1.35754
9.71	1.35772
13.49	1.35834
15.10	1.35862
16.20	1.35871
29.30	1.36097
53.80	1.36537
67.30	1.36766
72.30	1.36940
89.90	1.37225
100.00	1.37470

$a = 1.35633$, $b = 0.148$, $c =$
 0.35 ; $\epsilon = 1$ or 2 ; $n_F^{22} = n_C^{22} +$
 0.00663 for $0 < \% B < 100$.

350. B = C₆H₆, Benzene (³⁹)

% A	n_D^{16}
0.0	1.5036
5.3	1.4962
9.8	1.4885
20.0	1.4723
31.0	1.4558
40.0	1.4426
49.5	1.4284
69.4	1.4011
84.7	1.3803
100.0	1.3609

351. B = C₆H₆N₂O₂, *o*-Nitro-
aniline; $t = 20^\circ\text{C} \text{ (}^{58}\text{)}$

% B	n_D^{25}	d_4^{25}
4.4756	1.3687	0.8089
5.0076	1.3689	0.8093

352. B = C₆H₆N₂O₂, *p*-Nitro-
aniline; $t = 20^\circ\text{C} \text{ (}^{58}\text{)}$

4.9334	1.3719	0.8111
5.6797	1.3736	0.8139

353. B = C₁₀H₈, Naphthalene
(⁷⁶)

% B	n_D^{25}	d_4^{25}	t
0.000	1.36126	0.7983	15.8
14.728	1.39380	0.8281	15.7
26.826	1.42257	0.8546	15.7
100.000	1.58218	0.9645	99.6

354. B = C₁₀H₁₆BrO, Bromo-
camphor (¹⁰⁴)

% B	n_D^{25}	d_4^{26}
0.000	1.3571	0.7881
0.7693	1.3577	0.7901
7.381	1.3637	0.8117
22.930	1.3807	0.8719
34.720	1.3948	0.9219
48.580	1.4137	0.9884

If % B < 50, $a = 1.3569$,
 $b = 0.917$, $c = 5.1$; $\epsilon = 1$ or 2 .

355. B = C₁₀H₁₆O, Camphor
(¹⁰⁴)

0.000	1.3569	0.7874
0.7962	1.3576	0.7887
3.054	1.3597	0.7915
5.037	1.3613	0.7949
9.992	1.3665	0.8021
24.270	1.3807	0.8241
37.830	1.3945	0.8461
50.730	1.4091	0.8673
66.940	1.4283	0.8962

If % B < 50, $a = 1.3569$, $b =$
 0.92 , $c = 2.1$; $\epsilon = 1$.

356. B = C₁₀H₁₈O, Borneol
(¹⁰³)

0.000	1.3571	0.7881
1.0302	1.3583	0.7860
2.9805	1.3613	0.7925
5.0730	1.3623	0.7960
9.9940	1.3675	0.8035
15.322	1.3739	0.8113
19.652	1.3791	0.8184
37.697	1.4005	0.8493

356.—(Continued)

If % B < 40, $a = 1.3571$,
 $b = 1.0245$; $c = 3.7$; $\epsilon = 2$ or 3 .

357. B = C₁₉H₂₂N₂O, Cincho-
toxine (¹⁰³)

g B/l soln.	n_D^{26}	d_4^{25}
0.00	1.3571	0.7881
5.160	1.3579	0.7898
21.136	1.3614	0.7951
41.592	1.3662	0.8015
60.348	1.3711	0.8100
88.712	1.3774	0.8152

358. B = C₂₆H₂₆N₂O₂, Ben-
zoylcinchotoxine (¹⁰³)

0.000	1.3571	0.7881
9.448	1.3581	0.7916
25.280	1.3623	0.7973
41.584	1.3651	0.8033
62.128	1.3726	0.8102

See also 32, 242, 251, 307, 316.

C₃H₆O₂

Propionic acid

359. B = C₁₀H₁₆O, Camphor
(⁵³)

% B	n_D^{20}	d_4^{20}
0.00	1.3847	0.9948
10.12	1.3940	0.9921
20.22	1.4026	0.9893
30.40	1.4123	0.9868
40.66	1.4213	0.9844
50.96	1.4309	0.9810

If % B < 50, $a = 1.3847$,
 $b = 0.905$, $c = 0$; $\epsilon = 1$ or 2 .

See also 33, 259, 559.

C₃H₆O₂

Methyl acetate; $v \text{ (}^{79}\text{)}$

C₃H₈O₃

Lactic acid; see 560

C₃H₈O

n-Propyl alcohol; cf. (¹²⁸)

360. B = C₅H₁₁I, Amyl iodide;
 $t = 25.1^\circ\text{C} \text{ (}^{153}\text{)}$

% B	n_D^{25}
0.00	1.38308
11.74	1.38976
22.41	1.39653
37.21	1.40740
45.35	1.41433
53.43	1.42071
60.15	1.42881
65.06	1.43453
73.79	1.44541
82.81	1.45792
86.78	1.46419
93.22	1.47559
97.12	1.48292
100.00	1.48863

Specific. rot. power of B was
 $[\alpha]_D = +1.54^\circ\text{cm}^2\text{g}^{-1}$.

361. B = C₁₀H₁₆O, Camphor;
t = 20°C (53)

% B	n _D ^t	d ₄ ^t
0.00	1.3855	0.8046
12.19	1.3940	0.8210
23.90	1.4030	0.8380
35.10	1.4124	0.8543
45.93	1.4212	0.8709
56.37	1.4293	0.8874

If % B < 40, a = 1.3855,
b = 0.66, c = 2.75; ε = 1 or 2.
See also 34, 260, 321.

C₃H₈O

Isopropyl alcohol; see 35, 322,
349

C₃H₈O₂

Methylal; see 243

C₃H₈O₃

Glycerol; see 36

C₄H₅NS

Allyl isothiocyanate

362. B = C₄H₁₁N, Diethyl-
amine; t = 25°C (52)

% B	n _D
0.00	1.52481
21.20	1.54033
32.60	1.54933
42.40	1.54928
53.97	1.51233
64.80	1.46856
100.00	1.38416

363. B = C₆H₁₁N Piperidine;
t = 25°C (52)

% B	n _D
0.0	1.53066
15.8	1.54750
31.1	1.56700
46.2	1.57300
60.9	1.54995
71.8	1.50166
83.6	1.47933
100.0	1.45542

C₄H₆O₄

Succinic acid; see 37, 561

C₄H₆O₅

Malic acid; see 38, 562

C₄H₆O₆

Tartaric acid; see 39, 563, 564

C₄H₈O₂

Butyric acid; see 262

C₄H₈O₂

Isobutyric acid; see 244 and
(44)

C₄H₈O₂

Ethyl acetate

364. B = C₁₀H₁₆BrO, Bromo-
camphor (104)

% B	n _D ²⁵	d ₄ ²⁵
0.000	1.3701	0.8947
0.4572	1.3710	0.8959
4.394	1.3749	0.9083
20.760	1.3920	0.9630
31.890	1.4049	1.0031
38.900	1.4136	1.0286

If % B < 40, a = 1.3704,
b = 0.96, c = 3.75; ε = 1 or 2.

365. B = C₁₀H₁₆O, Camphor
(104)

% B	n _D	d ₄
0.000	1.3704	0.8947
0.4656	1.3707	0.8951
1.119	1.3714	0.8953
2.671	1.3729	0.8967
4.468	1.3744	0.8979
8.882	1.3788	0.9004
22.000	1.3915	0.9091
34.850	1.4041	0.9176
51.690	1.4210	0.9283

If % B < 50, a = 1.3704,
b = 0.97, c = 0; ε = 1 or 2.

366. B = C₁₀H₁₈O, Borneol
(103)

% B	n _D	d ₄
0.000	1.3701	0.8947
0.8699	1.3711	0.8953
2.2461	1.3719	0.8965
4.433	1.3761	0.8976
8.951	1.3790	0.9004
17.663	1.3891	0.9063
26.301	1.3983	0.9127

If 0 < % B < 5, a = 1.3701,
b = 0.65, c = 50; ε = 2.

If 5 < % B < 25, a =
1.3691, b = 1.12, c = 0; ε = 2.
See also 234, 317.

C₄H₈S₂

Diethylene disulfide

367. B = C₈H₁₀, Xylene (26)

% A	n _D ^t	d ₄ ^t	t
0.00	1.48790	0.85744	22.8
8.44	1.49265	0.87719	28.0
8.47	1.49270	0.87732	23.2

C₄H₉Br

Butyl bromide; see 310

C₄H₉NO₆

Ammonium bitartrate; see 40

C₄H₁₀O

n-Butyl alcohol

368. B = C₈H₁₄O₆, Diethyl
tartrate (104)

% B	n _D ²⁵	d ₄ ²⁵
0.000	1.3979	0.8092
5.3231	1.3997	0.8206

368.—(Continued)

% B	n _D ²⁵	d ₄ ²⁵
23.1060	1.4067	0.8730
43.638	1.4148	0.9425
59.440	1.4228	1.0043
80.990	1.4339	1.1000

C₄H₁₀O

Isobutyl alcohol

369. B = C₈H₁₄O₆, Diethyl
tartrate (104)

% B	n _D ²⁵	d ₄ ²⁵
0.000	1.3944	0.7994
4.510	1.3960	0.8115
27.278	1.4044	0.8803
50.314	1.4157	0.9622
65.578	1.4240	1.0247
83.960	1.4353	1.1114

370. B = C₁₀H₁₆O, Camphor
(104)

% B	n _D	d ₄
0.000	1.3944	0.7994
0.9796	1.3957	0.8007
4.9447	1.3979	0.8065
23.984	1.4108	0.8330
46.148	1.4262	0.8666
56.654	1.4342	0.8825

If % B < 50, a = 1.3944,
b = 0.69, c = 0; ε = 1.

See also 245, 263, 323.

C₄H₁₀O

Trimethyl carbinol; see 41

C₄H₁₀O

Ethyl ether; see 246, 556 (42,
68, 75)

C₄H₁₀O₄

Erythritol; see 42

C₄H₁₁N

Diethylamine

371. B = C₇H₅NS, Phenyl
isothiocyanate (52)
t = 25°C

% A	n _D
0.00	1.64912
7.10	1.6373
16.20	1.6290
23.50	1.6245
35.10	1.6215
38.90	1.6060
42.60	1.5910
46.60	1.5710
58.80	1.5270
71.40	1.4867
80.50	1.4533
100.00	1.38725

See also 362.

C₄H₁₂N₂O₄

Ammonium succinate, see 43

C₄H₁₂N₂O₆

Ammonium tartrate; see 44

C₅H₄O₂

2-Furaldehyde; see 45

C₅H₅N

Pyridine

372. B = C₁₀H₈, Naphthalene
(76)

% B	n _D ^t	d ₄ ^t	t
0.000	1.51137	0.9842	16.8
9.413	1.52209	0.9887	16.9
29.426	1.54462	0.9976	17.0
100.000	1.58218	0.9645	99.6

373. B = C₁₃H₁₀N₄O₆,
α-Methylphenylpicramide (58)

% B	n _D ²⁰	d ₄ ²⁰
2.5590	1.5060	0.9919
2.5601	1.5063	0.9925

374. B = C₁₃H₁₀N₄O₆,
β-Methylphenylpicramide

% B	n _D ²⁰	d ₄ ²⁰
2.3446	1.5057	0.9911
2.5490	1.5059	0.9916

See also 46, 264, 311.

C₅H₁₀O₂

Valeric acid; see 266

C₅H₁₀O₂

Isovaleric acid; see 247

C₅H₁₀O₂

Propyl acetate

375. B = C₅H₁₀O₂, Ethyl pro-
pionate; t = 20°C (92)

% A	n _D
0.0000	1.53889
33.3914	1.53890
49.5407	1.53890
67.4112	1.53894
100.0000	1.53887

n is linear in % B for all λ's,
to accuracy of 0.0001.

C₅H₁₀O₂

Ethyl propionate; see 375

C₅H₁₁I

Amyl iodide; see 360

C₅H₁₁N

Piperidine

376. B = C₆H₆, Benzene;
t = 25°C (51)

% A	n _D
0.00	1.49856
15.56	1.49174
30.57	1.48402
40.77	1.47984
47.52	1.47289
58.12	1.47053
73.21	1.46459
82.79	1.45761
100.00	1.45542

See also 363.

C₅H₁₃NO₂

Ammonium valerate; see 47

$C_6H_4Br_2$ <i>m</i> -Dibromobenzene			
% A	n_D^{25}	d_4^{25}	<i>t</i>
0.000	1.63226	1.1018	9.6
52.574	1.62569	1.4342	9.4
0.000	1.62994	1.0979	14.8
29.635	1.62672	1.2634	14.8

$C_6H_4N_2O_5$ 2, 3-Dinitrophenol; <i>see</i> 275			
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$C_6H_4N_2O_5$ 2, 4-Dinitrophenol; <i>see</i> 276			
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$C_6H_4N_2O_5$ 2, 6-Dinitrophenol; <i>see</i> 277			
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$C_6H_4N_2O_5$ 3, 4-Dinitrophenol; <i>see</i> 278			
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$C_6H_4N_2O_5$ 3, 6-Dinitrophenol; <i>see</i> 279			
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C_6H_5Cl Chlorobenzene			
378. B = $C_{10}H_{16}O$, Camphor (104)			
% B	n_D^{25}	d_4^{25}	
0.000	1.5246	1.1010	
0.7255	1.5243	1.0992	
5.509	1.5216	1.0920	
18.643	1.5139	1.0719	
30.350	1.5071	1.0538	
59.250	1.4921	1.0138	
No simple relation between <i>n</i> and % B.			

$C_6H_5NO_2$ Nitrobenzene			
379. B = C_6H_7N , Aniline; <i>t</i> = 20°C (16)			
% B	n_D^{25}	d_4^{25}	
0.00	1.55296		
16.77	1.55902		
29.27	1.56331		
46.14	1.56913		
62.49	1.57443		
77.25	1.57919		
100.00	1.58672		

380. B = $C_{10}H_8$, Naphthalene (76)			
% B	n_D^{25}	d_4^{25}	<i>t</i>
0.000	1.55595	1.2099	13.5
8.875	1.56205	1.1901	14.6
20.327	1.57040	1.1671	14.6

381. B = $C_{10}H_9N$, α -Naphthylamine (76)			
% B	n_D^{25}	d_4^{25}	<i>t</i>
0.000	1.55246	1.2021	20.8
8.943	1.56519	1.1939	20.8

$C_6H_5NO_3$ <i>o</i> -Nitrophenol; <i>see</i> 281			
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$C_6H_5NO_3$ <i>m</i> -Nitrophenol; <i>see</i> 282			
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$C_6H_5NO_3$ <i>p</i> -Nitrophenol; <i>see</i> 283			
C_6H_6 Benzene; <i>cf.</i> (20, 39, 62, 75, 79, 130)			

382. B = C_6H_7N , Aniline; <i>t</i> = 25°C (51)			
% B	n_D^{25}	d_4^{25}	
0.00	1.49856		
23.95	1.51790		
36.88	1.53020		
50.44	1.54193		
66.68	1.55535		
75.85	1.56276		
84.09	1.56963		
100.00	1.58118		

383. B = $C_7H_7NO_2$, <i>m</i> -Nitrotoluene (33)			
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<i>t</i> = 15°C			
% B	n_D^{25}	d_4^{25}	
0.0	1.50439	0.8841	
30.5	1.51517	0.9536	
50.4	1.52475	1.0130	
72.4	1.53387	1.0692	
87.8	1.54208	1.1197	
100.0	1.54919	1.1603	
<i>t</i> = 30°C			
0.0	1.49534	0.8684	
30.5	1.50687	0.9379	
50.4	1.51698	0.9975	
72.4	1.52665	1.0538	
87.8	1.53520	1.1047	
100.0	1.54263	1.1483	

384. B = C_7H_9N , <i>m</i> -Toluidine (33)			
<i>t</i> = 15°C			
0.0	1.50439	0.8841	
25.1	1.51966	0.9097	
48.3	1.53405	0.9346	
67.1	1.54713	0.9564	
84.2	1.55898	0.9770	
100.0	1.57068	0.9970	
<i>t</i> = 30°C			
0.0	1.49534	0.8684	
25.1	1.51132	0.8947	
48.3	1.52600	0.9204	
67.1	1.53961	0.9428	
84.2	1.55181	0.9640	
100.0	1.56381	0.9848	

385. B = C_7H_{16} , Heptane (105)			
% B	n_D^{15}	$d_4^{8.5}$	
0.00	1.38855		
56.26	1.44063	0.78278	
100.00	1.50381	0.89137	

386. B = $C_8H_{18}O$, 1- β -Octanol (34)			
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% B	n_D^{20}	d_4^{20}	
0.00	1.5007	0.8788	
2.386	1.4983	0.8773	
2.989	1.4977	0.8767	
5.458	1.4954	0.8745	
5.666	1.4948	0.8737	
8.259	1.4929	0.8722	

386.—(Continued)			
% B	n_D^{20}	d_4^{20}	
9.942	1.4913	0.8704	
13.801	1.4876	0.8679	
18.933	1.4832	0.8647	
23.122	1.4798	0.8618	
23.742	1.4790	0.8608	
29.846	1.4738	0.8567	
36.021	1.4692	0.8532	
42.262	1.4642	0.8493	
49.430	1.4592	0.8453	
54.021	1.4556		
57.807	1.4530	0.8406	
61.631	1.4503	0.8385	
65.575	1.4475	0.8368	
68.481	1.4454	0.8358	
77.747	1.4395	0.8308	
84.473	1.4353	0.8276	
92.456	1.4304	0.8241	
98.098	1.4269	0.8218	
100.000	1.4259	0.8215	
Temperature controlled to $\pm 0.1^\circ$.			

387. B = $C_{10}H_{16}BrO$, Bromo- camphor; <i>t</i> = 25°C (104)			
% B	n_D^{25}	d_4^{25}	
0.000	1.5004	0.8728	
0.4665	1.4998	0.8743	
4.512	1.4999	0.8871	
21.210	1.5018	0.9431	
32.500	1.5032	0.9848	
46.120	1.5055	1.0409	
If % B < 45, <i>a</i> = 1.4997, <i>b</i> = 0.078, <i>c</i> = 1; ϵ = 1 or 2.			

388. B = $C_{10}H_{16}O$, Camphor <i>t</i> = 18.5°C (53)			
0.00	1.5017	0.8814	
11.07	1.4980	0.8893	
21.87	1.4945	0.8983	
33.28	1.4912	0.9063	
43.70	1.4882	0.9155	
54.20	1.4853	0.9237	
<i>t</i> = 20°C (53)			
0.00	1.5014	0.8809	
11.30	1.4961	0.8861	
22.34	1.4931	0.8953	
33.18	1.4903	0.9042	
43.82	1.4874	0.9130	
54.28	1.4842	0.9215	

<i>n</i> is not linear in % B. <i>t</i> = 25°C (104)			
0.000	1.4997	0.8728	
0.4472	1.4990	0.8728	
0.928	1.4987	0.8736	
2.722	1.4985	0.8748	
4.550	1.4986	0.8766	
9.097	1.4970	0.8802	
22.470	1.4936	0.8913	
35.480	1.4897	0.9019	
52.373	1.4848	0.9164	
If % B < 50, <i>a</i> = 1.4997, <i>b</i> = -0.2593, <i>c</i> = -0.53; ϵ = 1.			

389. B = $C_{10}H_{18}O$, Borneol; = 25°C (103)			
% B	n_D^{25}	d_4^{25}	
0.000	1.5004	0.8728	
0.9238	1.4995	0.8737	
2.3214	1.4992	0.8747	
4.586	1.4985	0.8765	
11.348	1.4973	0.8813	
16.940	1.4960	0.8864	
22.455	1.4953	0.8909	
If % B < 20, <i>a</i> = 1.5004, <i>b</i> = -0.4, <i>c</i> = 8; ϵ = 2.			

390. B = $C_{10}H_{20}O_2$, 1- β -Octyl acetate (34)			
% B	n_D^{20}	d_4^{20}	
0.000	1.5015	0.8802	
4.350	1.4974	0.8787	
9.738	1.4923	0.8777	
15.842	1.4865	0.8762	
23.142	1.4796	0.8742	
29.168	1.4742	0.8732	
36.850	1.4673	0.8718	
43.254	1.4619	0.8708	
55.207	1.4516	0.8687	
70.726	1.4388	0.8661	
81.118		0.8645	
87.987	1.4245	0.8632	
96.747	1.4176	0.8622	
100.000	1.4153	0.8617	

Same sample of C_6H_6 as for
 $C_8H_{18}O$, but it has probably
absorbed traces of H_2O . Tem-
perature controlled to 0.1°C.

391. B = $C_{16}H_{18}N_2$, Diphenyl- piperazine (25)			
% B	n_D^{22}	d_4^{22}	
0.00	1.49484	0.87605	
3.64	1.49915	0.88315	
4.78	1.50028*	0.88517*	
* <i>t</i> = 21°C.			

392. B = $C_{16}H_{20}N_2$, <i>sym</i> .-Di- phenyldimethylethylenedi- amine (25)			
0.00	1.49484	0.87605	
10.30	1.50536	0.89334	
11.46	1.50719*	0.89594*	
* <i>t</i> = 21.5°C.			

393. B = $C_{18}H_{22}N_2$, Dibenzyl- piperazine (25)			
0.00	1.49484	0.87605	
11.09	1.50221	0.89215	
13.52	1.50360	0.89536	

394. B = $C_{27}H_{44}$, α -Choles- terylene (24)			
% B	n_D^{20}	d_4^{20}	
0.000	1.50093	0.87862	
6.639	1.50207	0.88340	
10.412	1.50290	0.88612	

395. B = $C_{27}H_{46}$, Cholestene (24)			
0.000	1.50093	0.87862	
10.104	1.50113	0.88426	
17.979	1.50182	0.88912	

396. B = C₂₇H₄₆O, Cholesterol

(24)		
% B	n_D^{20}	d_4^{20}
0.000	1.50093	0.87862
6.018	1.50165	0.88420
6.628	1.50170	0.88476

397. B = C₂₇H₄₈, Cholestane
(24)

% B	n_D^{20}	d_4^{20}
0.000	1.50093	0.87862
6.151	1.50076	0.88164

398. B = C₂₉H₄₈OS₂, Methyl
cholesteryl xanthogenate (24)

% B	n_D^{20}	d_4^{20}
0.000	1.50093	0.87862
6.772	1.50366	0.88830
11.355	1.50561	0.89506

399. B = C₂₉H₅₀OS₂, Methyl
dihydrocholesteryl xanthogen-
ate (24)

% B	n_D^{20}	d_4^{20}
0.000	1.50093	0.87862
10.987	1.50482	0.89386
15.665	1.50663	0.90056

See also 235, 284, 308, 312,
324, 350, 376, 552, 557.

C₆H₆N₂O₂*o*-Nitroaniline; see 351C₆H₆N₂O₂*p*-Nitroaniline; see 352C₆H₆O

Phenol; see 48

C₆H₆O₃S

Benzenesulfonic acid; see 285

C₆H₇N

Aniline

400. B = C₉H₇N, Quinoline
(76)

% A	n_D^t	d_4^t	t
0.000	1.62694	1.0929	20.7
9.709	1.62455	1.0870	20.9
16.679	1.62250	1.0827	20.8
100.000	1.58592	1.0217	20.7

401. B = C₁₀H₈, Naphthalene
(76)

% B	n_D^t	d_4^t	t
0.000	1.58857	1.0248	16.5
9.998	1.59116	1.0239	17.2
20.037	1.59418	1.0234	17.8

402. B = C₁₀H₉N,
 α -Naphthylamine (76)

% B	n_D^t	d_4^t	t
0.000	1.58552	1.2632*	21.1
10.880	1.59548	1.0301	21.1

See also 49, 313, 325, 379, 382.

* This is obviously wrong.

C₆H₈O₂

Cyclohexan-1, 4-dione; see 326

C₆H₈O₇

Citric acid; see 50, 544, 565, 566

C₆H₁₀O

Cyclohexanone

403. B = C₁₀H₈, Naphthalene
(76)

% B	n_D^t	d_4^t	t
0.000	1.45171	0.9488	17.9
12.678	1.47227	0.9590	17.8
22.190	1.48788	0.9669	17.6

C₆H₁₀O₄

Diethyl oxalate; see 252

C₆H₁₂

Cyclohexane

404. B = C₇H₇NO₂, *m*-Nitro-
toluene (33)

% B	n_D^t	d_4^t
$t = 15^\circ\text{C}$		
0.0	1.42890	0.7830
29.8	1.45329	0.8662
50.0	1.47498	0.9347
70.4	1.50194	1.0158
86.8	1.52614	1.0923
100.0	1.54919	1.1630

 $t = 30^\circ\text{C}$

0.0	1.42206	0.7696
29.8	1.44718	0.8525
50.0	1.46861	0.9198
70.4	1.49553	1.0014
86.8	1.51974	1.0776
100.0	1.54263	1.1483

405. B = C₇H₉N, *m*-Toluidine
(33) $t = 15^\circ\text{C}$

0.0	1.42890	0.7830
24.1	1.45480	0.8249
45.7	1.48171	0.8669
61.7	1.50582	0.9015
82.4	1.53791	0.9509
100.0	1.57068	0.9970

 $t = 30^\circ\text{C}$

0.0	1.42206	0.7696
24.1	1.44821	0.8117
45.7	1.47513	0.8538
61.7	1.49921	0.8886
82.4	1.53145	0.9382
100.0	1.56381	0.9848

C₆H₁₂O₂

Isobutyl acetate

406. B = C₇H₁₄O₂, Ethyl
isovalerate; $t = 20^\circ\text{C}$ (92)

% B	n_D^t
0.0000	1.54444
18.7251	1.54552
31.3151	1.54622
48.3989	1.54734
64.4828	1.54824
77.1855	1.54894
100.0000	1.55026

100*n* = $n_A(\% \text{ A}) + n_B(\% \text{ B}) \pm 0.0001$.C₆H₁₂O₂

Ethyl butyrate

407. B = C₆H₁₂O₂, Ethyl
isobutyrate; $t = 20^\circ\text{C}$ (92)

% B	n_D^t
0.0000	1.54624
25.4236	1.54511
49.0035	1.54403
74.2817	1.54298
100.0000	1.54181

100*n* = $n_A(\% \text{ A}) + n_B(\% \text{ B}) \pm 0.0001$.

C₆H₁₂O₂

Ethyl isobutyrate; see 407

C₆H₁₂O₆

Fructose; see 51

C₆H₁₂O₆

Glucose; see 52

C₆H₁₄

Hexane

408. B = C₇H₇NO₂, *m*-Nitro-
toluene (33)

% B	n_D^t	d_4^t
$t = 15^\circ\text{C}$		
0.0	1.37805	0.6680
28.3	1.41154	0.7614
53.1	1.44886	0.8658
69.7	1.48286	0.9522
86.6	1.51770	1.0591
100.0	1.54919	1.1630

 $t = 30^\circ\text{C}$

0.0	1.37025	0.6545
28.3	1.40451	0.7468
53.1	1.44263	0.8513
69.7	1.47650	0.9368
86.6	1.51132	1.0422
100.0	1.54263	1.1483

409. B = C₇H₉N, *m*-Toluidine
(33) $t = 22^\circ\text{C}$

0.0	1.37441	0.6617
27.7	1.41346	0.7277
44.9	1.44278	0.7761
63.1	1.47860	0.8361
83.1	1.52395	0.9138
100.0	1.56746	0.9913

 $t = 32^\circ\text{C}$

0.0	1.36921	0.6527
27.7	1.40928	0.7188
44.9	1.43916	0.7673
63.1	1.47493	0.8273
83.1	1.51973	0.9053
100.0	1.56289	0.9832

C₆H₁₄O₆

Dulcitol; see 53

C₆H₁₄O₆*d*-Mannitol; see 54C₆H₁₄O₆*d*-Sorbitol; see 55C₆H₁₅N

Triethylamine; see 56

C₆H₁₇N₃O₇

Ammonium citrate; see 57

C₇H₅NO₄*o*-Nitrobenzoic acid; see 290C₇H₅NO₄*m*-Nitrobenzoic acid; see 291C₇H₅NO₄*p*-Nitrobenzoic acid; see 292C₇H₅NS

Phenyl isothiocyanate; see 371

C₇H₅NS

Phenyl thiocyanate; see (154)

C₇H₅N₃O₆

2, 4, 6-Trinitrotoluene; see 587

C₇H₆N₂O₄

2, 4-Dinitrotoluene; see 587

C₇H₆N₂O₄*o*-Nitrophenylnitromethane;
see 295C₇H₆N₂O₄*p*-Nitrophenylnitromethane;
see 296C₇H₆O

Benzaldehyde

410. B = C₉H₇N, Quinoline (76)

% A	n_D^t	d_4^t	t
0.000	1.63025	1.0979	14.9
17.090	1.61565	1.0899	14.8

C₇H₆O₂

Benzoic acid

411. B = C₉H₇N, Quinoline
(76); see also 297

0.000	1.62626	1.0930	19.1
40.079	1.60326	1.1388	19.1
0.000	1.62517	1.0911	21.6
13.418	1.61740	1.1061	21.6
45.882	1.59883	1.1433	21.5
0.000	1.62395	1.0890	25.0
10.202	1.61838	1.1007	24.6

C₇H₇Br

Benzyl bromide

412. B = C₇H₇Cl, Benzyl
chloride; $t = 20^\circ\text{C}$ (92)

% B	n_D^t
0.0000	1.52505
18.8772	1.53165
23.3439	1.53347
33.0428	1.53669
48.0849	1.54197
65.3828	1.54820
73.9944	1.55130
78.9757	1.55295
100.0000	1.56042

100*n* = $n_A(\% \text{ A}) + n_B(\% \text{ B}) \pm 0.0002$.

C₇H₇ClBenzyl chloride; *see* 412**C₇H₇NO₂***m*-Nitrotoluene413. B = C₇H₇N, Toluene (33)

% B	$n_D^{t_{5893}}$	d_4^t
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 $t = 15^\circ\text{C}$

0.0	1.54919	1.1630
14.4	1.54052	1.1095
30.7	1.53160	1.0544
49.6	1.52177	0.9970
72.7	1.51131	0.9353
100.0	1.49985	0.8715

 $t = 30^\circ\text{C}$

0.0	1.54263	1.1483
14.4	1.53388	1.0948
30.7	1.52451	1.0398
49.6	1.51468	0.9825
72.7	1.50366	0.9210
100.0	1.49178	0.8576

414. B = C₇H₁₄, Methylcyclohexane (33) $t = 15^\circ\text{C}$

0.0	1.54919	1.1630
15.3	1.52368	1.0792
32.3	1.49887	0.9988
51.8	1.47368	0.9208
73.9	1.44845	0.8465
100.0	1.42535	0.7734

 $t = 30^\circ\text{C}$

0.0	1.54263	1.1483
15.3	1.51746	1.0646
32.3	1.49261	0.9845
51.8	1.46766	0.9069
73.9	1.44214	0.8330
100.0	1.41864	0.7603

See also 404, 408.**C₇H₇NO₂***p*-Nitrotoluene; *see* 587**C₇H₈**Toluene; *cf.* (75)415. B = C₇H₉N, *m*-Toluidine (33)

% B	$n_D^{t_{5893}}$	d_4^t
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 $t = 15^\circ\text{C}$

0.0	1.49985	0.8715
19.0	1.51203	0.8928
45.9	1.53043	0.9247
65.4	1.54443	0.9495
82.4	1.55698	0.9722
100.0	1.57068	0.9970

 $t = 30^\circ\text{C}$

0.0	1.49178	0.8756
19.0	1.50430	0.8790
45.9	1.52279	0.9114
65.4	1.53715	0.9365
82.4	1.54991	0.9595
100.0	1.56381	0.9848

416. B = C₁₂H₁₂O₂, 2-Benzoylcyclopentanone (9)

% B	n_D^t	d_4^t	t
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0.000	1.49515	0.86002	25.0
5.895	1.50123	0.8717	25.2

417. B = C₁₃H₁₄O₂, 2-Benzoylcyclohexanone (9)

% B	n_D^t	d_4^t	t
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See also 236, 304, 314, 327, 413, 586.**C₇H₈O***m*-Cresol418. B = C₉H₇N, Quinoline (76)

% B	n_D^t	d_4^t	t
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0.000	1.54135	1.0338	20.4
88.167	1.61989	1.0908	19.0
88.584	1.61977	1.0897	20.4
100.000	1.62724	1.0935	20.0
100.000	1.62724	1.0931	20.5

419. B = C₁₀H₈, Naphthalene (76)

0.000	1.54246	1.0363	18.0
9.556	1.55019	1.0351	18.0
13.000	1.55278	1.0349	18.0

C₇H₈O

Anisole

420. B = C₉H₇N, Quinoline (76)

80.358	1.61146	1.0835	8.0
84.809	1.61273	1.0821	15.0
100.000	1.63342	1.1024	8.8
100.000	1.63007	1.0977	15.0

421. B = C₁₀H₈, Naphthalene (76)

0.000	1.51950	0.9989	16.5
11.013	1.53103	1.0018	16.6
19.089	1.53951	1.0043	16.8

C₇H₉N*o*-Toluidine422. B = C₉H₇N, Quinoline; $t = 20.7^\circ\text{C}$ (76)

% B	n_D^t	d_4^t
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0.000	1.57222	0.9977
90.527	1.62299	1.0849
100.000	1.62694	1.0929

423. B = C₁₀H₉N, α -Naphthylamine; $t = 20.7^\circ\text{C}$ (76)

0.000	1.57222	0.9977
10.926	1.58351	1.0100

C₇H₉N*m*-Toluidine424. B = C₇H₁₄, Methylcyclohexane (33)

% B	n_D^t	d_4^t
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0.0	1.57068	0.9970
18.6	1.53797	0.9456
37.9	1.50771	0.8979
57.9	1.47802	0.8528
78.1	1.45025	0.8125
100.0	1.42535	0.7734

424.—(Continued)

% B	n_D^t	d_4^t
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 $t = 30^\circ\text{C}$

0.0	1.56381	0.9848
18.6	1.53148	0.9332
37.9	1.50141	0.8852
57.9	1.47151	0.8399
78.1	1.44400	0.7995
100.0	1.41864	0.7603

See also 384, 405, 409, 415.**C₇H₉NO₂**Ammonium benzoate; *see* 58**C₇H₉NO₃**Ammonium salicylate; *see* 59**C₇H₁₂O₆**Quinic acid; *see* 60, 567**C₇H₁₄**Methylcyclohexane; *see* 414, 424**C₇H₁₄O₂**Ethyl isovalerate; *see* 406**C₇H₁₄O₆** α -Methylglucoside; *see* 61**C₇H₁₄O₆** β -Methylglucoside; *see* 61**C₇H₁₆**

Heptane

425. B = C₁₀H₇Br, α -Bromonaphthalene (105)

% B	n_D^{15}	d_{15}^t	t
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See also 318, 385.**C₈H₇N**

Benzyl cyanide

426. B = C₈H₁₀O, Phenetole (105)

% B	n_D^{15}	d_{15}^t	t
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See also 318, 385.**C₈H₈O**

Acetophenone

427. B = C₉H₇N, Quinoline (76)

% B	n_D^t	d_4^t	t
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428. B = C₁₀H₈, Naphthalene (76)

0.000	1.53660	1.0308	14.9
13.423	1.54866	1.0311	14.9
14.198	1.54941	1.0311	14.9

429. B = C₁₀H₉N, α -Naphthylamine (76)

0.000	1.53355	1.0249	20.7
0.936	1.54893	1.0352	20.7

C₈H₈O₂Phenylacetic acid; *see* 62, 568**C₈H₈O₃**Phenylglycolic acid; *see* 63, 569**C₈H₉Br**Bromo-*p*-xylene430. B = C₉H₇N, Quinoline (76)

% B	n_D^t	d_4^t	t
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See also 384, 405, 409, 415.**C₈H₁₀**

Ethylbenzene

431. B = C₈H₁₀, *o*-Xylene (92)

% B	n_D^{20}
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 $a = 1.50497$, $b = -0.0905$, $c = 0.062$; $\epsilon = 1$.432. B = C₈H₁₀, *m*-Xylene (92)

0.000	1.49843
24.6565	1.49786
50.3372	1.49728
78.8580	1.49673
100.000	1.49659

 $a = 1.49843$, $b = -0.0276$, $c = 0.092$, $\epsilon = 1$.433. B = C₈H₁₀, *p*-Xylene (92)

0.000	1.49625
25.2055	1.49632
51.1066	1.49635
75.2683	1.49646
100.000	1.49659

 n_D is linear in % B; $\epsilon = 1$.**C₈H₁₀***o*-Xylene434. B = C₈H₁₀, *m*-Xylene; $t = 20^\circ\text{C}$ (92)

% B	n_D^t
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 n_D is linear in % B; $\epsilon = 1$.435. B = C₈H₁₀, *p*-Xylene; $t = 20^\circ\text{C}$ (92)

0.000	1.50497
24.9410	1.50292
49.4932	1.50075
74.7171	1.49852
100.000	1.49625

 n_D is linear in % B; $\epsilon = 1$. *See also* 367, 431.

C ₈ H ₁₀ <i>m</i> -Xylene	
436. B = C ₈ H ₁₀ , <i>p</i> -Xylene; <i>t</i> = 20°C (92)	
% B	<i>n</i> _D ^t
0.000	1.49840
24.9807	1.49828
50.2550	1.49772
75.0229	1.49712
100.000	1.49625
a = 1.49840, b = -0.0013, c = -0.202; ε = 1. See also 432, 434.	

C ₈ H ₁₀ <i>p</i> -Xylene; see 433, 435, 436	
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C ₈ H ₁₀ N ₂ O <i>p</i> -Nitrosodimethylaniline (31)	
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C ₈ H ₁₀ O Phenetole; see 426	
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C ₈ H ₁₄ O ₆ Diethyl tartrate; see 368, 369	
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C ₈ H ₁₈ O 1-β-Octanol; see 386	
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C ₉ H ₆ Br ₂ O ₂ Dibromocinnamic acid; see 328	
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C ₉ H ₇ BrO ₂ α-Bromocinnamic acid; see 329	
---------------------------------------------------------------------------------	--

C ₉ H ₇ BrO ₂ β-Bromocinnamic acid; see 330	
---------------------------------------------------------------------------------	--

C ₉ H ₇ BrO ₂ α-Bromoalocinnamic acid; see 331	
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C ₉ H ₇ BrO ₂ β-Bromoalocinnamic acid; see 332	
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C ₉ H ₇ ClO ₂ α-Chlorocinnamic acid; see 333	
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C ₉ H ₇ ClO ₂ α-Chloroalocinnamic acid; see 334	
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C ₉ H ₇ N Quinoline	
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437. B = C ₉ H ₅ N ₂ O, 2-Acetyl- indazole (76)	
% B	<i>n</i> _D ^t
0.000	1.62728
10.013	1.62378

438. B = C ₉ H ₁₀ O ₂ , <i>o</i> -Ethyl- benzoic acid (76)	
% B	<i>n</i> _D ^t
0.000	1.62799
0.000	1.62724
10.659	1.61973
11.817	1.61936
46.712	1.59482
100.000	1.51012
100.000	1.50993

439. B = C ₉ H ₁₀ O ₂ , Ethyl benzoate (76)	
% B	<i>n</i> _D ^t
0.000	1.63342
14.974	1.61483

440. B = C ₉ H ₁₂ , <i>p</i> -Methyl- ethylbenzene (76)	
% B	<i>n</i> _D ^t
0.000	1.63226
0.000	1.63006
18.346	1.60286
53.375	1.57714*
100.000	1.49896

441. B = C ₁₀ H ₆ Cl ₂ , 1, 4- Dichloronaphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62954
14.297	1.63161

442. B = C ₁₀ H ₆ Cl ₂ , 1, 5- Dichloronaphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62872
8.541	1.62986
9.835	1.63021
Max. solubility is ca. 13 % B.	

443. B = C ₁₀ H ₆ Cl ₂ , 1, 7- Dichloronaphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62854
9.195	1.62990
28.217	1.63237
100.000	1.60921

444. B = C ₁₀ H ₆ Cl ₂ , 1, 8- Dichloronaphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62877
10.086	1.63110
38.683	1.63811
100.000	1.62357

445. B = C ₁₀ H ₆ Cl ₂ , 2, 7- Dichloronaphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62845
9.984	1.62968
10.510	1.62973

446. B = C ₁₀ H ₇ Cl, β-Chloro- naphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62945
10.011	1.62985

447. B = C ₁₀ H ₇ I, α-Iodo- naphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62775
100.000	1.70540

448. B = C ₁₀ H ₇ I, β-Iodo- naphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62775
16.824	1.63702
100.000	1.66617

449. B = C ₁₀ H ₈ , Naphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62880
14.438	1.62863
16.104	1.62847

450. B = C ₁₀ H ₈ O, α-Naphthol (76)	
% B	<i>n</i> _D ^t
0.000	1.62755
10.971	1.63393
100.000	1.62240

451. B = C ₁₀ H ₈ O, β-Naphthol (76)	
% B	<i>n</i> _D ^t
0.000	1.62816
9.841	1.63328
15.571	1.63634

452. B = C ₁₀ H ₉ N, α-Naph- thylamine (76)	
% B	<i>n</i> _D ^t
0.000*	1.62751
9.494	1.63473
9.954	1.63547
17.358	1.64072
100.000*	1.67032
100.000*	1.66932

453. B = C ₁₀ H ₉ N, β-Naph- thylamine (76)	
% B	<i>n</i> _D ^t
0.000	1.62577
9.548	1.63383
10.682	1.63449
15.315	1.63828
16.808	1.63927

454. B = C ₁₀ H ₁₀ N ₂ , 1, 4-Naph- thylenediamine (76)	
% B	<i>n</i> _D ^t
0.000	1.62881
11.352*	1.64414

455. B = C ₁₀ H ₁₀ N ₂ , 1, 5-Naph- thylenediamine (76)	
% B	<i>n</i> _D ^t
0.000	1.62966
8.408	1.64301
9.646	1.64462

456. B = C ₁₀ H ₁₀ N ₂ , 1, 6-Naph- thylenediamine (76)	
% B	<i>n</i> _D ^t
0.000	1.62657
10.189	1.64149
14.498	1.64752
100.000	1.70831

457. B = C ₁₀ H ₁₀ N ₂ , 1, 8-Naph- thylenediamine (76)	
% B	<i>n</i> _D ^t
0.000	1.62608
9.125	1.63681
28.692	1.65770
100.000*	1.68278

458. B = C ₁₀ H ₁₀ N ₂ , 2, 3-Naph- thylenediamine (76)	
% B	<i>n</i> _D ^t
0.000	1.62395
0.000	1.62256
7.476	1.63390
8.029	1.63426

459. B = C ₁₀ H ₁₀ N ₂ , 2, 7-Naph- thylenediamine (76)	
% B	<i>n</i> _D ^t
0.000	1.63040
0.000	1.62846
9.581	1.64465
9.652	1.64289

460. B = C ₁₀ H ₁₄ , <i>p</i> -Cymene (76)	
% B	<i>n</i> _D ^t
0.000	1.63058
0.000	1.63007
16.046	1.60566
18.486	1.60138
52.013	1.55396
100.000	1.49271

461. B = C ₁₀ H ₁₄ O, <i>p</i> -Tolyl- dimethyl carbinol (76)	
% B	<i>n</i> _D ^t
0.000	1.63072
19.223	1.60933
100.000	1.52215

462. B = C ₁₁ H ₈ O, α-Naphthal- dehyde (76)	
% B	<i>n</i> _D ^t
0.000	1.62539
14.012	1.62920
44.593	1.63748
100.000	1.65464

463. B = C ₁₁ H ₈ O, β-Naphthal- dehyde (76)	
% B	<i>n</i> _D ^t
0.000	1.62597
28.679	1.63272
100.000	1.62107

464. B = C ₁₁ H ₁₂ O, 1-Keto-7- methyl-1, 2, 3, 4-tetrahydro- naphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62917
33.830	1.60647
100.000	1.55674

465. B = C ₁₂ H ₈ O, Diphenyl- ene oxide (76)	
% B	<i>n</i> _D ^t
0.000	1.63072
12.824	1.63302

466. B = C ₁₂ H ₁₀ , Diphenyl (76)	
% B	<i>n</i> _D ^t
0.000	1.63093
17.311	1.62948

467. B = C ₁₂ H ₁₂ O, β-Naphthyl ethyl ether (76)	
% B	<i>n</i> _D ^t
0.000	1.62923
10.607	1.62707

468. B = C ₁₂ H ₁₃ N, α-Ethyl- aminonaphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62788
9.130	1.63114
48.730	1.64280
100.000	1.64773

469. B = C ₁₂ H ₁₃ N, β-Ethyl- aminonaphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62541
11.512	1.63032
46.552	1.64273
100.000*	1.65175
100.000†	1.65440

* Prepared from pure acetyl compound.
† Purified by recrystallization of hydrochloride.

470. B = C ₁₃ H ₇ Cl ₃ , Trichloro- fluorene (76)	
% B	<i>n</i> _D ^t
0.000	1.63212
0.000	1.62917
9.479	1.63242
9.735	1.63567
9.906	1.63230

471. B = C ₁₃ H ₅ Br ₂ , 2, 7-Di- bromofluorene (76)	
% B	<i>n</i> _D ^t
0.000	1.62679
0.000	1.62455
9.201	1.63084
9.532	1.62964
10.776	1.63082

472. B = C ₁₃ H ₈ O, Fluorenone (76)	
% B	<i>n</i> _D ^t
0.000	1.62924
10.846	1.63349

473. B = C ₁₃ H ₁₀ , Fluorene (76)	
% B	<i>n</i> _D ^t
0.000	1.62924
9.171	1.63092

474. B = C ₁₃ H ₁₂ , Diphenyl- methane (76)	
% B	<i>n</i> _D ^t
0.000	1.62986
17.968	1.62099

475. B = C ₁₃ H ₁₂ O, 1-Methyl- 2-acetylnaphthalene (76)	
% B	<i>n</i> _D ^t
0.000	1.62819
43.769	1.62743
100.000	1.62695

C₉H₇N.—(Continued)476. B = C₁₃H₁₂O₂, Ethyl β -naphthoate (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62926	1.0975	15.6
10.530	1.62601	1.0998	15.6

477. B = C₁₃H₁₄, 1-Methyl-2-ethyl-naphthalene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62837	1.0970	16.0
64.421	1.61066	1.0338	15.7
100.000	1.60138	1.0014	15.4

478. B = C₁₄H₈Br₂, 9, 10-Dibromoanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.59096	1.0309	99.5
0.000	1.59087	1.0310	99.6
9.114	1.60060	1.0697	99.7
9.776	1.60137	1.0724	99.6

479. B = C₁₄H₈Cl₂, 1, 4-Dichloroanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.59110	1.0310	99.0
0.000	1.59105	1.0311	99.1
9.064	1.59937	1.0498	99.2
9.678	1.60000	1.0510	99.0

480. B = C₁₄H₈Cl₂, 1, 5-Dichloroanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.59090	1.0305	99.3
0.000	1.59082	1.0308	99.4
8.278	1.59854	1.0477	99.3
10.255	1.60037	1.0520	99.4

481. B = C₁₄H₈Cl₂, 9, 10-Dichloroanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.59077	1.0310	99.3
0.000	1.59072	1.0311	99.3
9.828	1.60113	1.0535	99.2
9.972	1.60141	1.0535	99.3

482. B = C₁₄H₈Cl₂, 9, 10-Dichlorophenanthrene (6)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62271	1.0875	25.4
6.644	1.62733	1.1032	25.6
5.981	1.62733	1.1023	25.5

483. B = C₁₄H₉Cl, α -Chloroanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62924	1.0962	17.0
0.000	1.62821	1.0947	18.9
0.000	1.59032	1.0302	100.3
11.891	1.60214	1.0452	99.7
13.780	1.64149	1.1111	18.8
19.448	1.64797	1.1194	16.7
100.000	1.69589	1.1707	99.5

484. B = C₁₄H₉Cl, β -Chloroanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.59078	1.0306	99.7
9.258	1.60000	1.0422	99.6
10.346	1.60110	1.0435	99.7

485. B = C₁₄H₉Cl, 9-Chloroanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63072	1.0984	14.1
0.000	1.63054	1.0985	14.4
11.713	1.64183	1.1139	14.4
12.214	1.64317	1.1148	14.1

486. B = C₁₄H₉Cl, 9-Chlorophenanthrene (6)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62315	1.0888	25.6
9.986	1.62963	1.1032	25.7

486.—(Continued)

% B	n_D^{20}	d_4^{20}	t
10.714	1.62821	1.1019	25.7
100.000	1.67393	1.2167	100.5

487. B = C₁₄H₁₀, Anthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.59078	1.0307	99.4
9.822	1.60087	1.0325	99.5
10.950	1.60187	1.0335	99.5

488. B = C₁₄H₁₀, Phenanthrene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62990	1.0972	15.6
10.653	1.63749	1.0997	15.7
25.995	1.64835	1.1032	15.7
100.000	1.68588	1.0412*	129.6

* $t = 131^\circ\text{C}$.489. B = C₁₄H₁₀Br₂, 2, 7-Dibromo-9-methylfluorene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63118	1.0985	13.8
10.013	1.63574	1.1391	13.7
17.244	1.63899	1.1699	13.8

490. B = C₁₄H₁₂, 9, 10-Dihydroanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62911	1.0959	17.3
13.749	1.62774	1.0946	17.2
18.578	1.62743	1.0944	17.0

491. B = C₁₄H₁₂, Dihydrophenanthrene (6)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62323	1.0906	24.6
9.319	1.62979	1.0940	24.5
9.911	1.63015	1.0942	24.5

492. B = C₁₄H₁₂, Stilbene (6)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62577	1.0943	20.5
9.673	1.63134	1.0888	19.9
9.709	1.63108	1.0883	21.7

493. B = C₁₄H₁₄O, 1-Ethyl-4-acetylnaphthalene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62819	1.0971	16.0
39.667	1.62446	1.0950	16.0
100.000	1.61979	1.0922	15.7

494. B = C₁₄H₁₅NO, α -Acetyl-ethylaminonaphthalene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62649	1.0931	20.2
12.087	1.62276	1.0933	20.3
100.000	1.59471	1.0888	27.3
100.000	1.56440	1.0359	99.0

495. B = C₁₄H₁₅NO, β -Acetyl-ethylaminonaphthalene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62473	1.0899	24.1
9.873	1.62252	1.0903	23.5
48.278	1.61320	1.0900	23.5
100.000	1.60312	1.0893	23.1

496. B = C₁₄H₁₇N, α -Diethylaminonaphthalene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62833	1.0953	18.0
10.258	1.62509	1.0861	18.0
44.072	1.61369	1.0565	18.0
100.000	1.59331	1.0071	18.1

497. B = C₁₄H₁₇N, β -Diethylaminonaphthalene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62539	1.0915	22.1
10.871	1.62685	1.0840	21.8

497.—(Continued)

% B	n_D^{20}	d_4^{20}	t
46.652	1.63008	1.0600	21.9
100.000	1.63210	1.0242	21.6

498. B = C₁₄H₁₇N, 1, 4-Diethylaminonaphthalene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63054	1.0987	14.2
23.080	1.61905	1.0753	14.2
100.000	1.53943	0.9318	99.6

499. B = C₁₄H₁₇N, 2, 3-Diethylaminonaphthalene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62569	1.0917	20.6
10.137	1.62219	1.0809	20.7
16.494	1.62014	1.0748	20.8
100.000	1.55589	0.9371	99.3

500. B = C₁₄H₂₄N₂, Tetraethyl-*o*-phenylenediamine (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63192	1.1010	10.7
19.935	1.60944	1.0653	10.6
100.000	1.52134	0.9267	12.6

501. B = C₁₄H₂₄N₂, Tetraethyl-*m*-phenylenediamine (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63176	1.1007	11.2
13.739	1.62174	1.0804	10.8
46.892	1.59629	1.0303	11.0
100.000	1.55367	0.9522	11.8

502. B = C₁₄H₂₄N₂, Tetraethyl-*p*-phenylenediamine (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63192	1.1010	10.7
14.310	1.62032	1.0788	10.4
100.000	1.50551	0.8795	99.3

503. B = C₁₅H₁₀, Fluoranthene (6)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62647	1.0942	18.6
9.974	1.63693	1.0996	18.7
0.000*	1.62778	1.0969	15.8
14.023*	1.64269	1.1045	15.2

* A second preparation.

504. B = C₁₅H₁₁Cl, 1-Methyl-4-chloroanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62920	1.0959	17.2
13.007	1.63971	1.1108	17.2
16.596	1.64259	1.1152	17.2

505. B = C₁₅H₁₂, α -Methylanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63033	1.0980	14.5
0.000	1.62985	1.0973	15.6
9.213	1.63839	1.0975	15.3
16.901	1.64587	1.0983	14.4
17.059	1.64570	1.0978	15.1
100.000	1.68027	1.0471	99.4

506. B = C₁₅H₁₂, β -Methylanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.59073	1.0308	99.1
0.000	1.59087	1.0310	99.5
8.604	1.59855	1.0303	99.6
9.409	1.59914	1.0307	99.3

507. B = C₁₅H₁₂O, 9-Methylanthracene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63011	1.0980	14.9
0.000	1.62916	1.0964	17.0
9.851	1.64030	1.0997	14.7
10.518	1.64006	1.0987	16.7
100.000	1.69589	1.0657	99.4

508. B = C₁₅H₁₂O, Anthranol methyl ether (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62938	1.0960	17.2
10.801	1.63833	1.1014	17.2
17.879	1.64417	1.1050	17.2
100.000	1.67855	1.0941	99.3

509. B = C₁₅H₁₄, *m*-Methylstilbene (76)

% B	n_D^{20}	d_4^{20}	t
0.000	1.63009	1.0982	14.5
13.297	1.63495	1.0879	14.7

510. B = C₁₆H₁₀, Pyrene (6)

% B	n_D^{20}	d_4^{20}	t
0.000	1.62726	1.0949	17.1
13.783	1.64528	1.1052	17.0
0.000*	1.62647	1.0942	18.6
9.789*	1.63927	1.1012	18.8

* A second preparation.

511. B = C₁₆H₁₃Cl, 9-Ethyl-10-chloroanthracene (76)

% B	n_D^t	d_4^t	t
0.000	1.63137	1.0993	13.0
0.000	1.63076	1.0981	14.2
10.527	1.64092	1.1112	12.6
11.080	1.64067	1.1107	14.2

C₉H₃N₂O 2-Acetylindazole; <i>see</i> 437			
C₉H₁₀O₂ <i>o</i> -Ethylbenzoic acid; <i>see</i> 438			
C₉H₁₀O₂ Ethyl benzoate; <i>see</i> 439			
C₉H₁₂ <i>p</i> -Methylethylbenzene; <i>see</i> 440			
C₁₀H₆Cl₂ 1, 4-Dichloronaphthalene			
516. B = C ₁₀ H ₁₂ , Tetralin (76)			
% A	<i>n</i> _D ^t	<i>d</i> ₄ ^t	<i>t</i>
0.000	1.54614	0.9729	20.2
12.072	1.55558	1.0062	20.2
517. B = C ₁₀ H ₁₅ N, Diethyl-aniline (76)			
0.000	1.54392	0.9372	16.7
12.456	1.55404	0.9747	16.7
518. B = C ₁₂ H ₁₄ O ₄ , Diethyl phthalate (76)			
0.000	1.50444	1.1245	17.7
13.994	1.52121	1.1502	17.6
519. B = C ₁₂ H ₁₆ O ₂ , Amyl benzoate (76)			
0.000	1.49498	0.9910	17.4
12.770	1.50988	1.0248	18.3
<i>See also</i> 441			
C₁₀H₆Cl₂ 1, 5-Dichloronaphthalene; <i>see</i> 442			
C₁₀H₆Cl₂ 1, 7-Dichloronaphthalene; <i>see</i> 443			
C₁₀H₆Cl₂ 1, 8-Dichloronaphthalene; <i>see</i> 444			
C₁₀H₆Cl₂ 2, 7-Dichloronaphthalene; <i>see</i> 445			
C₁₀H₇Br α -Bromonaphthalene; <i>see</i> 319, 425 (154)			
C₁₀H₇Cl β -Chloronaphthalene; <i>see</i> 446			
C₁₀H₇I α -Iodonaphthalene; <i>see</i> 447			
C₁₀H₇I β -Iodonaphthalene; <i>see</i> 448			
C₁₀H₈ Naphthalene; <i>cf.</i> (42)			
520. B = C ₁₀ H ₁₅ N, Diethyl-aniline (76)			
% A	<i>n</i> _D ^t	<i>d</i> ₄ ^t	<i>t</i>
0.0000	1.54619	0.9407	12.3
10.171	1.55423	0.9502	12.9
20.922	1.56287	0.9603	13.2

521. B = C ₁₂ H ₁₄ O ₄ , Diethyl phthalate (76)			
% A	<i>n</i> _D ^t	<i>d</i> ₄ ^t	<i>t</i>
0.000	1.50486	1.1250	16.8
11.274	1.51903	1.1136	17.5
20.912	1.53154	1.1043	17.5
522. B = C ₁₂ H ₁₆ O ₂ , Amyl benzoate (76)			
0.000	1.49601	0.9930	15.3
17.568	1.51788	0.9996	15.5
18.873	1.51953	1.0000	15.6
523. B = C ₁₄ H ₁₀ , Anthracene (144)			
% B	<i>n</i> _D ^t	<i>d</i> ₄ ^t	<i>t</i>
0.000	1.58996	0.9757	85.30
7.976	1.58932	0.9773	90.35
524. B = C ₁₄ H ₁₀ , Phenanthrene (144)			
0.000	1.58996	0.9757	85.30
8.539	1.59427	0.9800	87.65
43.126	1.61844	1.0062	88.42
<i>See also</i> 299, 305, 353, 372, 380, 401, 403, 419, 421, 428, 449.			
C₁₀H₈O α -Naphthol; <i>see</i> 450			
C₁₀H₈O β -Naphthol; <i>see</i> 451			
C₁₀H₉N α -Naphthylamine			
525. B = C ₁₀ H ₁₂ , Tetralin (76)			
% A	<i>n</i> _D ^t	<i>d</i> ₄ ^t	<i>t</i>
0.000	1.54605	0.9728	20.6
10.572	1.55893	0.9866	20.7
<i>See also</i> 381, 402, 423, 429, 452.			
C₁₀H₉N β -Naphthylamine; <i>see</i> 453			
C₁₀H₁₀N₂ 1, 4-Naphthalenediamine; <i>see</i> 454			
C₁₀H₁₀N₂ 1, 5-Naphthalenediamine; <i>see</i> 455			
C₁₀H₁₀N₂ 1, 6-Naphthalenediamine; <i>see</i> 456			
C₁₀H₁₀N₂ 1, 8-Naphthalenediamine; <i>see</i> 457			
C₁₀H₁₀N₂ 2, 3-Naphthalenediamine; <i>see</i> 458			
C₁₀H₁₀N₂ 2, 7-Naphthalenediamine; <i>see</i> 459			
C₁₀H₁₂ Tetralin; <i>see</i> 516, 525			

C₁₀H₁₂O Anethole (154)			
C₁₀H₁₂O₂ Eugenol			
526. B = Oil of cinnamon (96)			
% A	0.0	80.0	
<i>t</i>	<i>n</i> _D ^t		
19.7		1.5556	
29.6	1.5923	1.5508	
35.1	1.5902	1.5484	
41.1		1.5453	
527. B = Sandalwood oil (96)			
% A	0.0	20.0	40.0
<i>t</i>	<i>n</i> _D ^t		
19.7	1.5086	1.5147	1.5208
29.6	1.5048	1.5105	1.5166
35.1	1.5024	1.5083	1.5142
41.1	1.5001	1.5056	1.5117
% A	60.0	80.0	100.0
<i>t</i>	<i>n</i> _D ^t		
19.7	1.5276	1.5347	1.5422
29.6	1.5232	1.5304	1.5377
35.1	1.5207	1.5277	1.5351
41.1	1.5182	1.5250	1.5324
If <i>t</i> = 19.7°C, <i>a</i> = 1.5086, <i>b</i> = 0.284, <i>c</i> = 0.52.			
If <i>t</i> = 29.6, <i>a</i> = 1.5048, <i>b</i> = 0.275, <i>c</i> = 0.54.			
If <i>t</i> = 35.1, <i>a</i> = 1.5024, <i>b</i> = 0.273, <i>c</i> = 0.54.			
If <i>t</i> = 41.4, <i>a</i> = 1.5001, <i>b</i> = 0.273, <i>c</i> = 0.5.			
In all cases ϵ = 1.			
C₁₀H₁₄ <i>p</i> -Cymene; <i>see</i> 460			
C₁₀H₁₄N₂ Nicotine; <i>see</i> 64			
C₁₀H₁₄O <i>p</i> -Tolyldimethyl carbinol; <i>see</i> 461			
C₁₀H₁₅BrO Bromocamphor; <i>see</i> 335, 354, 364, 387			
C₁₀H₁₅N Diethylaniline; <i>see</i> 517, 520			
C₁₀H₁₆O Camphor; <i>see</i> 253, 300, 315, 336, 355, 359, 361, 365, 370, 378, 388			
C₁₀H₁₈O Borneol; <i>see</i> 337, 356, 366, 389			
C₁₀H₂₀O₂ 1- β -Octyl acetate; <i>see</i> 390			
C₁₁H₈O α -Naphthaldehyde; <i>see</i> 462			
C₁₁H₈O β -Naphthaldehyde; <i>see</i> 463			

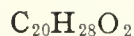
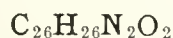
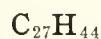
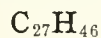
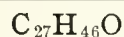
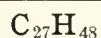
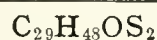
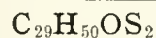
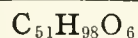
C₁₁H₁₂O 1-Keto-7-methyl-1, 2, 3, 4-tetrahydronaphthalene; <i>see</i> 464			
C₁₂H₈O Diphenylene oxide; <i>see</i> 465			
C₁₂H₁₀ Diphenyl; <i>see</i> 301, 466			
C₁₂H₁₀N₂ Azobenzene (40, 72)			
C₁₂H₁₀O 4-Methylnaphthaldehyde (76)			
C₁₂H₁₀O Methylnaphthyl ketone (76)			
C₁₂H₁₂O β -Naphthyl ethyl ether; <i>see</i> 467			
C₁₂H₁₂O₂ 2-Benzoylcyclopentanone; <i>see</i> 338, 416			
C₁₂H₁₃N α -Ethylaminonaphthalene; <i>see</i> 468			
C₁₂H₁₃N β -Ethylaminonaphthalene; <i>see</i> 469			
C₁₂H₁₄O₄ Diethyl phthalate; <i>see</i> 518, 521			
C₁₂H₁₆O₂ Amyl benzoate; <i>see</i> 519, 522			
C₁₂H₂₂O₁₁ Lactose; <i>see</i> 65			
C₁₂H₂₂O₁₁ Sucrose (cane sugar); <i>see</i> 66 (43)			
C₁₃H₇Cl₃ Trichlorofluorene; <i>see</i> 470			
C₁₃H₈Br₂ 2, 7-Dibromofluorene; <i>see</i> 471			
C₁₃H₈O Fluorenone; <i>see</i> 472			
C₁₃H₁₀ Fluorene; <i>see</i> 473			
C₁₃H₁₀N₄O₆ α -Methylphenylpicramide; <i>see</i> 373			
C₁₃H₁₀N₄O₆ β -Methylphenylpicramide; <i>see</i> 374			
C₁₃H₁₀O₃ Phenyl salicylate (salol); <i>see</i> (90)			
C₁₃H₁₂ Diphenylmethane; <i>see</i> 474			

$C_{13}H_{12}O$ 1-Methyl-2-acetylnaphthalene; <i>see</i> 475
$C_{13}H_{12}O$ 2-Methyl-(5)8-acetylnaphthalene (76)
$C_{13}H_{12}O_2$ Ethyl β -naphthoate; <i>see</i> 476
$C_{13}H_{13}N$ Benzylaniline (72)
$C_{13}H_{14}$ 1-Methyl-2-ethylnaphthalene; <i>see</i> 477
$C_{13}H_{14}$ 1-Methyl-4-ethylnaphthalene (76)
$C_{13}H_{14}O_2$ 2-Benzoylcyclohexanone; <i>see</i> 339, 417
$C_{14}H_8Br_2$ 9, 10-Dibromoanthracene; <i>see</i> 478
$C_{14}H_8Cl_2$ 1, 4-Dichloroanthracene; <i>see</i> 479
$C_{14}H_8Cl_2$ 1, 5-Dichloroanthracene; <i>see</i> 480
$C_{14}H_8Cl_2$ 9, 10-Dichloroanthracene; <i>see</i> 481
$C_{14}H_8Cl_2$ 9, 10-Dichlorophenanthrene; <i>see</i> 482
$C_{14}H_9Br$ 10-Bromophenanthrene (6)
$C_{14}H_9Cl$ α -Chloroanthracene; <i>see</i> 483
$C_{14}H_9Cl$ β -Chloroanthracene; <i>see</i> 484
$C_{14}H_9Cl$ 9-Chloroanthracene; <i>see</i> 485
$C_{14}H_9Cl$ 9-Chlorophenanthrene; <i>see</i> 486
$C_{14}H_{10}$ Anthracene; <i>see</i> 487, 523
$C_{14}H_{10}$ Phenanthrene; <i>see</i> 488, 524
$C_{14}H_{10}Br_2$ 2, 7-Dibromo-9-methylfluorene; <i>see</i> 489

$C_{14}H_{12}$ 9, 10-Dihydroanthracene; <i>see</i> 490
$C_{14}H_{12}$ Dihydrophenanthrene; <i>see</i> 491
$C_{14}H_{12}$ Stilbene; <i>see</i> 492
$C_{14}H_{14}$ α -Tetrahydrophenanthrene (6)
$C_{14}H_{14}O$ 1-Ethyl-4-acetylnaphthalene; <i>see</i> 493
$C_{14}H_{15}NO$ α -Acetylethylaminonaphthalene; <i>see</i> 494
$C_{14}H_{15}NO$ β -Acetylethylaminonaphthalene; <i>see</i> 495
$C_{14}H_{16}$ 1, 4-Diethylnaphthalene; <i>see</i> (76)
$C_{14}H_{17}N$ α -Diethylaminonaphthalene; <i>see</i> 496
$C_{14}H_{17}N$ β -Diethylaminonaphthalene; <i>see</i> 497
$C_{14}H_{17}N$ 1, 4-Diethylaminonaphthalene; <i>see</i> 498
$C_{14}H_{17}N$ 1, 5-Diethylaminonaphthalene (76)
$C_{14}H_{17}N$ 1, 8-Diethylaminonaphthalene (76)
$C_{14}H_{17}N$ 2, 3-Diethylaminonaphthalene; <i>see</i> 499
$C_{14}H_{17}N$ 2, 6-Diethylaminonaphthalene (76)
$C_{14}H_{17}N$ 2, 7-Diethylaminonaphthalene (76)
$C_{14}H_{24}N_2$ Tetraethyl- <i>o</i> -phenylenediamine; <i>see</i> 500
$C_{14}H_{24}N_2$ Tetraethyl- <i>m</i> -phenylenediamine; <i>see</i> 501
$C_{14}H_{24}N_2$ Tetraethyl- <i>p</i> -phenylenediamine; <i>see</i> 502

$C_{15}H_{10}$ Fluoranthrene; <i>see</i> 503
$C_{15}H_{11}Cl$ 1-Methyl-4-chloroanthracene; <i>see</i> 504
$C_{15}H_{12}$ α -Methylantracene; <i>see</i> 505
$C_{15}H_{12}$ β -Methylantracene; <i>see</i> 506
$C_{15}H_{12}$ 9-Methylantracene; <i>see</i> 507
$C_{15}H_{12}Br_2$ 2, 7-Dibromo-9-ethylfluorene (76)
$C_{15}H_{12}O$ Anthranol methyl ether; <i>see</i> 508
$C_{15}H_{14}$ α -Methylstilbene (76)
$C_{15}H_{14}$ <i>m</i> -Methylstilbene; <i>see</i> 509
$C_{15}H_{16}O$ 1-Methyl-4-ethyl-2-acetylnaphthalene (76)
$C_{15}H_{18}$ 1-Methyl-2, 4-diethylnaphthalene (76)
$C_{16}H_{10}$ Pyrene; <i>see</i> 510
$C_{16}H_{13}Cl$ 9-Ethyl-10-chloroanthracene; <i>see</i> 511
$C_{16}H_{14}$ 9-Ethylantracene (76)
$C_{16}H_{14}$ 9-Ethylphenanthrene (76)
$C_{16}H_{16}O$ Ethylhydroanthranol; <i>see</i> 512
$C_{16}H_{18}N_2$ Diphenylpiperazine; <i>see</i> 391
$C_{16}H_{20}N_2$ <i>sym.</i> -Diphenyldimethylethylenediamine; <i>see</i> 392
$C_{16}H_{32}O_2$ Palmitic acid 528. B = $C_{18}H_{34}O_2$, Oleic acid (101)
% B
0.00
9.90
22.30
36.50
50.59
64.44

528.—(Continued)
% B
79.70
90.40
100.00
529. B = $C_{18}H_{36}O_2$, Stearic acid (101)
0.00
10.46
25.00
40.00
53.85
70.00
90.00
100.00
<i>See also</i> 342, 588 and Figs. 4, 5, 6.
$C_{17}H_{12}O_3$ Naphthyl salicylate (betol) (90)
$C_{17}H_{14}Br_2O_2$ Ethyl 2, 7-dibromofluorene-9-acetate; <i>see</i> 513
$C_{18}H_{18}$ Retene; <i>see</i> 514
$C_{18}H_{22}N_2$ Dibenzylpiperazine; <i>see</i> 343, 393
$C_{18}H_{34}O_2$ Oleic acid 530. B = $C_{18}H_{36}O_2$, Stearic acid (101)
% B
0.00
10.00
20.00
30.58
44.05
60.00
74.70
86.53
100.00
<i>See also</i> 345, 528, 588 and Figs. 4, 5, 6.
$C_{18}H_{36}O_2$ Stearic acid; <i>see</i> 346, 529, 530, 588
$C_{19}H_{16}$ Triphenylmethane; <i>see</i> 302
$C_{19}H_{20}$ 9-Isoamylantracene (76)
$C_{19}H_{22}N_2O$ Cinchotoxine (Cinchonicine); <i>see</i> 347, 357
$C_{20}H_8Br_4O_5$ Eosin (143)
$C_{20}H_{28}O_2$ 1, 4-Dihydroxynaphthalene diamyl ether (76)

1, 5-Dihydroxynaphthalene
diamyl ether; *see* 515Benzoyleinchotoxine (benzoyl-
cinchonine); *see* 348, 358 α -Cholesterylene; *see* 394Cholestene; *see* 395Cholesterol; *see* 396Cholestane; *see* 397Methyl cholesterylkanthogen-
ate; *see* 398Methyl dihydrocholesterylkan-
thogenate; *see* 399

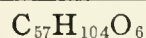
Tripalmitin

531. B = $C_{57}H_{104}O_6$, Triolein
(101)

% B	n_D^{60}	n_D^{70}	n_D^{80}
0.00	1.4428	1.4402	1.4376
10.00	1.4443	1.4417	1.4391
23.57	1.4462	1.4434	1.4406
34.35	1.4475	1.4447	1.4419
45.00	1.4487	1.4459	1.4431
52.47	1.4498	1.4468	1.4438
61.05	1.4512	1.4481	1.4450
67.58	1.4518	1.4488	1.4458
79.30	1.4533	1.4500	1.4467
79.65	1.4534	1.4502	1.4476
90.10	1.4549	1.4513	1.4477
100.00	1.4561	1.4523	1.4485

532. B = $C_{57}H_{110}O_6$, Tristearin
(101)

0	1.4427	1.4402	1.4377
10	1.4430	1.4404	1.4378
20	1.4434	1.4407	1.4380
31.15	1.4442	1.4409	1.4376
40	1.4450	1.4410	1.4370
50	1.4455	1.4410	1.4365
60	1.4454	1.4410	1.4366
65.15	1.4453	1.4410	1.4367
75	1.4450	1.4411	1.4372
78.75	1.4447	1.4411	1.4375
90	1.4445	1.4412	1.4379
100	1.4441	1.4413	1.4385



Triolein

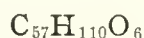
533. B = $C_{57}H_{110}O_6$, Tristearin
(101)

% B	n_D^{60}	n_D^{70}	n_D^{80}
0.00	1.4561	1.4523	1.4485
14.29	1.4546	1.4506	1.4466

533.—(Continued)

% B	n_D^{60}	n_D^{70}	n_D^{80}
27.27	1.4534	1.4491	1.4448
38.46	1.4522	1.4480	1.4438
51.02	1.4506	1.4467	1.4428
68.15	1.4485	1.4448	1.4411
86.05	1.4464	1.4431	1.4398
100.00	1.4441	1.4413	1.4385

See also 531, 589 and Figs.
7, 8, 9.

Tristearin (stearin); *see* 532,
533, 589Acetoacetic ester
derivatives (60, 89)

Albumen (127)

Albumin

See Table 4.

Oil of Bergamot

534. B = Sandalwood oil (96)

% B	0.0	60.0	80.0
t	n_D^t		
19.7		1.4907	1.4996
29.6	1.4613	1.4863	1.4959
35.1	1.4588	1.4842	1.4932
41.1		1.4819	1.4905

Blood serum

See Table 4 and (46)

Castor oil (42)

Cinnamon, Oil of

See 526 (154)

Diketones (140, 142)

Dyestuffs, Commercial
(32)Eosin derivatives
(143)

Gelatin

See 228.1

Glyoximes (23)

Nitroaniline derivatives
(59)

Paraffin oil (42)

Proteins

See Table 4

Sandalwood oil

See 527, 534

Turpentine, Oil of (62)

TABLE 2.—REFRACTIVITY AT ONE WAVE-LENGTH (D): TERNARY
MIXTURES

For dispersion and refraction at other wave-lengths, *see* end of Table 5. For order of arrangement, *see* Vol. III, p. viii; for refractivity of corresponding binary mixtures, *see* same authority in Table 1. (Pulfrich) (Abbe-Zeiss) . . . indicate the type of refractometer used.

$\delta_d^t + 1000 = 1000d_4^t$, $\delta_n^t + 1333 = 1000n_D^t$, M_C = g-moles C per liter of mixture; % B = g B per 100 g of mixture; 1 Vol. B + 2 Vol. C = mixture of 1 volume of solution containing B to 2 volumes of solution containing C; Vol. % B, t° = volume % of B at t° C; g B/l soln. = g B per liter of mixture.

I. Aqueous Mixtures, Standard Arrangement

535. B = HIO_3 ; C = MoO_3
(113)

g B/l soln.	g C/l soln.	δ_n^{26}	δ_d^{26}
4.4867	0	0.11	0.93
0	12.0676	1.74	7.08
1 Vol. B + 2 Vol. C	1.14	4.93	

536. B = HIO_3 , $M_B = 0.5$;C = $NaOH$, $M_C = 0.5$; $t = 21^\circ C$ (28)

Vol.	% B, 21°	n_D^t
0.0		1.3380
9.0		1.3382
16.7		1.3384
23.0		1.3385
33.3		1.3387
41.2		1.3389
45.4		1.3390
47.6		1.3391
50.0		1.3392
52.6		1.3395
55.5		1.3397
58.8		1.3401
62.5		1.3405
66.6		1.3409
71.5		1.3414
77.0		1.3421
83.3		1.3426
91.0		1.3435
100.0		1.3444

538. B = HIO_4 , $M_B = 0.5$;C = $NaOH$, $M_C = 0.5$; $t = 26^\circ C$ (28)

Vol.	% B, 21°	n_D^t
43.5		1.3376
45.4		1.3374
47.7		1.3372
50.0		1.3372
52.7		1.3376
55.6		1.3381
58.8		1.3386
62.5		1.3391
66.7		1.3396
71.4		1.3403
77.0		1.3413
83.4		1.3422
91.0		1.3433
100.0		1.3445

539. B = HIO_4 , $M_B = 0.967$;C = KOH , $M_C = 1.0$; $t = 25^\circ C$ (28)

	n_D^t
0.0	1.3427
4.7	1.3430
9.0	1.3433
13.0	1.3437
16.6	1.3440
20.0	1.3443
23.0	1.3445
25.8	1.3446
28.5	1.3446
31.0	1.3445
33.3	1.3445

540. B = H_2SeO_3 , $M_B = 1.0$;C = NH_4OH , $M_C = 1.0$; $t = 19^\circ C$ (28)

	n_D^t
16.2	1.3379
23.1	1.3395
28.6	1.3408
33.3	1.3421
37.5	1.3422
41.2	1.3422
44.5	1.3422
47.4	1.3423
50.0	1.3423

541. B = HNO_3 ;C = $Hg(NO_3)_2$ (Pulfrich)

Anhydrous (94)

% C	n_D^{20}	d_4^{20}
0	1.3394	1.0253
5.3037	1.3451	1.0767
0	1.3423	1.0373
6.6201	1.3495	1.1014

H₂O.—(Continued)542. B = HNO₃; C = Hg₂-(NO₃)₂ (Pulfrich), Anhydrous

(94)		
% C	n_D^{20}	d_4^{20}
0	1.3385	1.0209
4.0118	1.3424	1.0563
7.4925	1.3465	1.0913
0	1.3394	1.0253
7.9896	1.3477	1.0991

543. B = NH₄OH, M_B = 2;
C = H₃PO₃, M_C = 2; $t = 19^\circ\text{C}$ (28)

Vol. % C	n_D^t
15	1.3406
20	1.3426
25	1.3446
30	1.3464
33.3	1.3478
40	1.3468
45	1.3461
50	1.3454
65	1.3455

544. B = NH₄OH, M_B = 2.0;
C = C₆H₈O₇, Citric acid,
M_C = 2.0; $t = 15^\circ\text{C}$ (28)

0.0	1.3352
10.0	1.3438
15.0	1.3476
20.0	1.3520
25.0	1.3563
30.0	1.3578
40.0	1.3608
50.0	1.3640
60.0	1.3672
70.0	1.3704
80.0	1.3736
90.0	1.3768
100.0	1.3800

545. B = (NH₄)₂SO₄; C =
Al₂(SO₄)₃ (113)

g B/l soln.	g C/l soln.	δ_n^{25}	δ_d^{25}
0	68.475	14.10	68.88
26.440	0	3.79	12.44
1 Vol. B + 1 Vol. C		8.94	40.94

546. B = (NH₄)₂SO₄; C =
K₂SO₄ (113)

0	33.872	3.61	24.37
26.440	0	3.79	12.44
1 Vol. B + 1 Vol. C		3.70	18.40

547. B = P₂O₅; C = MoO₃
(113)

3.2267	0	0.41	0.79
0	12.0844	2.14	8.32
1 Vol. B + 2 Vol. C		1.56	5.73

548. B = H₃PO₃, M_B = 2;
C = KOH, M_C = 2; $t = 17.5^\circ\text{C}$ (28)

Vol. % B	n_D^t
0.0	1.3530
9.1	1.3515
16.7	1.3504
23.1	1.3493
28.6	1.3485
33.3	1.3476
37.5	1.3469
41.2	1.3464
44.5	1.3459
47.4	1.3454
50.0	1.3450
52.6	1.3450
55.5	1.3451
58.8	1.3452
62.5	1.3454
66.6	1.3457
71.4	1.3458
76.9	1.3462
83.3	1.3465
90.9	1.3472
100.0	1.3479

549. B = H₃PO₄, M_B = 2;
C = KOH, M_C = 2; $t = 12$ to 12.5°C (28)

Vol. % B	n_D^t	d_4^t
0.0	1.3538	1.0964
4.7	1.3534	
9.1	1.3530	
16.7	1.3525	1.0983
20.0	1.3522	
23.1	1.3520	
24.5	1.3518	1.0991
25.9	1.3515	
28.6	1.3509	1.0977
31.0	1.3505	
33.3	1.3500	1.0960
37.5	1.3493	1.0947
41.2	1.3488	1.0936
44.5	1.3484	
47.4	1.3482	1.0927
50.0	1.3480	
52.6	1.3480	1.0929
55.5	1.3481	
58.8	1.3482	1.0940
62.5	1.3483	
66.6	1.3484	1.0957
71.4	1.3486	
76.9	1.3489	1.0980
83.8	1.3493	
90.9	1.3499	1.1025
100.0	1.3507	1.1056

550. B = H₄P₂O₇, M_B = 0.5;
C = KOH, M_C = 1.0; $t = 15^\circ\text{C}$ (28)

Vol. % B	n_D^t
0.0	1.3439
9.1	1.3431
16.2	1.3425
23.1	1.3420
28.6	1.3416
33.3	1.3412

550.—(Continued)

Vol. % B	n_D^t
37.5	1.3410
41.2	1.3408
44.5	1.3407
47.4	1.3406
50.0	1.3404
52.6	1.3405
55.5	1.3406
58.8	1.3407

550.—(Continued)

Vol. % B	n_D^t
62.5	1.3409
66.6	1.3411
71.4	1.3414
76.9	1.3418
83.8	1.3422
90.9	1.3429
100.0	1.3435

551. B = As₂O₅; C = MoO₃ (113)

g B/l soln.	g C/l soln.	δ_n^{25}	δ_d^{25}
12.7597	0	1.40	8.45
0	12.0844	2.14	8.32
1 Vol. B + 1 Vol. C		1.79	8.41

552. B = C₆H₆, Benzene; * C = CH₃O, Methyl alcohol (7)

* No numerical values of n ; a triangular diagram too small for accurate reproduction; analyses of layers in heterogeneous portion; it is stated that at 25°C the area of the heterogeneous portion = 0.7658 of total area of the triangular diagram, in contrast with 0.6739 for the system C₂H₅OH-C₆H₆-H₂O; v. 557.

B = C₆H₆, Benzene; C = C₂H₅O, Ethyl alcohol, v. 557553. B = C₂H₂O₄, Oxalic acid; C = MoO₃ (113)

3.1407	0	-0.11	-1.34
0	12.0676	1.74	7.08
1 Vol. B + 1 Vol. C		-0.18	2.89

554. B = C₂H₄O₂, Acetic acid; C = MoO₃ (113)

183.753	0	18.10	32.35
0	5.7626	0.51	1.86
2 Vol. B + 1 Vol. C		12.67	23.34

555. B = C₂H₄O₃, Glycolic acid; C = MoO₃ (113)

40.4302	0	3.32	10.06
0	4.80345	0.37	1.19
1 Vol. B + 2 Vol. C		1.44	4.23

556. B = C₂H₅O, Ethyl alcohol, $\delta_n^{15} = 30.66$; C = C₄H₁₀O, Ethyl ether, $\delta_n^{15} = 22.43$; for H₂O, $\delta_n^{15} = 0.39$; (Zeiss) $t = 15^\circ\text{C}$ (125)

% C	0	5	10
% B	δ_n^{15}		
0	0.39	4.506	
5	3.670	8.240	
10	7.290	12.111	
15	11.184	15.841	
20	15.246	19.272	22.510
25	18.579	22.294	24.860
30	21.574	24.860	27.128
35	24.348	26.837	28.630
40	26.516	28.343	30.158
45	28.378	29.945	31.360
50	30.050	31.174	32.280
55	31.120	32.242	33.155
60	32.070	33.120	33.540
65	32.980	33.540	33.820
70	33.435	33.785	33.855
75	33.715	33.855	33.715
80	33.875	33.680	33.225
85	33.645	33.225	32.105
90	33.159	32.070	30.554
95	32.000	30.590	
100	30.66		
% C	15	20	25
% B	δ_n^{15}		
25	26.732		
30	28.558	29.800	30.695
35	30.050	31.115	31.820

556.—(Continued)

% C	15	20	25
% B	δ_n^{15}		
40	31.185	32.175	32.840
45	32.245	33.050	33.400
50	33.190	33.575	33.820
55	33.505	33.855	33.890
60	33.855	33.960	33.610
65	33.925	33.645	32.910
70	33.680	33.050	31.856
75	33.225	32.070	29.905
80	32.105	30.230	
85	30.302		
% C	30	35	40
% B	δ_n^{15}		
30	31.150	31.712	32.105
35	32.350	32.700	32.875
40	33.190	33.365	33.190
45	33.610	33.575	33.085
50	33.750	33.310	32.350
55	33.540	32.455	31.010
60	32.870	31.360	28.990
65	31.640	29.310	
70	29.765		
% C	45	50	55
% B	δ_n^{15}		
30	32.280	32.420	31.856
35	32.875	32.385	31.325
40	32.805	31.856	30.050
45	32.140	30.554	28.090
50	30.835	28.630	
55	28.954		
% C	60	65	70
% B	δ_n^{15}		
20			29.800
25	31.115	30.302	28.847
30	30.835	29.240	26.948
35	29.590	27.272	
40	27.632		
% C	75	80	90
% B	δ_n^{15}		
10			24.068
15		27.380	
20	28.055	25.436	
25	26.120		
% B = 5	% C = 95	$\delta_n^{15} = 23.132$	
% B = 0	% C = 100	$\delta_n^{15} = 22.43$	

557. B = C₂H₆O, Ethyl alcohol; * C = C₆H₆, Benzene, D, 25°C
(Fery, direct reading) (8); see Fig. 1

% B	% C	δ_n^{25}	d_4^{25}
0.00	0.00	— 0.7	0.99707
0.00	100.00	+164.9	0.87363
5.85	93.66	145.0	
5.86	93.90	155.2	
5.89	94.11	155.0	
10.00	0.00	5.8	0.98043
10.00	89.93	148.5	0.86309
10.00	90.00	148.7	0.86299
10.09	88.93	147.7	
10.09	89.30	148.1	

557.—(Continued)

% B	% C	δ_n^{25}	d_4^{25}
10.9	89.91	148.8	
18.48	81.52	136.1	0.85503
20.00	0.00	13.0	0.96639
20.00	76.97	129.8	
20.00	77.69	130.7	0.85668
20.00	80.00	133.6	
21.42	77.16	129.8	
24.02	73.31	124.5	
27.06	68.80	117.8	
29.54	65.12	113.2	
30.00	0.00	18.4	0.95067
30.00	0.40	18.5	
30.00	0.50	18.6	
30.00	63.20	110.3	
30.00	63.81	111.0	0.85430
30.00	65.44	113.2	0.85161
30.00	67.28	114.9	0.84897
30.00	67.58	115.9	0.84818
30.00	70.00	118.8	0.84474
32.42	60.85	107.3	0.85287
35.26	56.64	101.5	
38.08	52.46	96.0	0.85238
40.00	0.00	23.5	0.93148
40.00	0.40	24.1	0.93063
40.00	1.23	25.1	
40.00	1.50	25.7	
40.00	48.61	90.7	0.85332
40.00	54.31	97.7	0.84490
40.00	59.72	104.3	0.83600
40.00	60.00	104.6	0.83574
40.68	48.61	90.9	
43.43	44.53	85.5	0.85199
45.96	40.78	80.5	
46.90	6.91	33.0	
47.13	5.46	32.4	
47.49	4.74	31.5	
49.85	1.22	28.0	0.90787
49.85	0.00	26.8	0.91019
49.83	35.04	72.8	
50.00	0.00	26.6	0.90985
49.86	2.64	30.6	
49.86	4.99	32.9	0.90068
50.00	5.87	33.8	0.89923
49.87	6.67	35.0	
49.87	7.43	36.2	
50.00	8.44	37.1	0.89460
49.88	9.03	38.5	
49.94	28.23	64.3	
49.94	29.30	65.7	
49.94	30.48	67.2	
50.00	30.80	67.3	0.87791
50.00	35.76	73.6	0.85000
50.00	39.85	78.9	0.84352
50.00	44.18	84.4	0.83613
50.00	50.00	90.9	0.82869
51.49	32.58	69.8	0.85189
60.00	0.00	28.7	0.88689
60.00	3.90	33.2	0.87958
60.00	7.05	37.3	0.87388
60.00	14.06	46.0	0.86180
60.00	19.16	52.1	0.85367
60.00	23.21	57.6	0.84701
60.00	28.60	64.5	0.83799

557.—(Continued)

% B	% C	δ_n^{25}	d_4^{25}
60.00	34.47	71.0	0.82797
60.00	40.00	77.3	0.81825
70.00	0.00	29.6	0.86340
70.00	7.46	38.7	0.85007
70.00	10.72	42.2	0.84421
70.00	14.68	46.8	0.83716
70.00	18.09	50.8	0.83165
70.00	22.45	55.5	0.82388
70.00	24.31	57.4	0.82014
70.00	25.64	58.8	0.81810
70.00	30.00	63.2	0.80953
73.46	0.00	29.8	0.85506
79.98	0.00	29.9	0.83911
79.98	3.58	33.7	0.83267
79.98	9.23	40.3	0.82271
79.99	13.75	45.0	0.81418
79.99	15.89	47.2	0.81021
79.99	20.01	50.9	0.80095
89.97	0.00	29.0	0.81369
89.94	2.42	31.4	0.80922
89.92	4.99	33.9	0.80418
89.90	7.53	36.6	0.79897
89.87	10.13	38.8	0.79343
100.00	0.00	26.2	0.78506

* At 25°C the area of the heterogeneous portion = 0.6739 of total area of triangular diagram.

558. B = $\text{C}_2\text{H}_6\text{O}$, Ethyl alcohol; C = $\text{Ca}(\text{NO}_3)_2$; concentration of $\text{C}_2\text{H}_6\text{O}$ in B \equiv % B; of C in B \equiv M_C; $t = 18^\circ\text{C}$ (93)

M _C	0.0	0.2	0.5
% B	δ_n		
0.0	0.1	6.8	11.4
18.5	12.1	15.8	21.5
41.2	25.9	30.0	35.6
60.8	30.3	34.3	39.4
74.0	32.0	36.3	42.0
91.9	30.5	34.5	40.8
100.0	26.9	32.1	39.0
M _C	1.0	1.5	2.0
% B	δ_n		
0.0	22.8	33.2	43.5
18.5	30.9	40.4	49.3
41.2	44.0	52.7	61.0
60.8	47.3	55.6	63.9
74.0	50.6	59.4	68.0
91.9	50.4	59.6	73.0
100.0	49.3	59.6	77.8

559. B = $\text{C}_3\text{H}_5\text{O}_2$, Propionic acid; C = MoO_3 , $t = 25^\circ\text{C}$ (113)

g B/l soln.	g C/l soln.	δ_n	δ_d
221.397	0	17.92	13.62
0	11.5253	1.57	6.60
2 Vol. B + 1 Vol. C		12.76	12.11

560. B = $\text{C}_3\text{H}_5\text{O}_3$, Lactic acid; C = MoO_3 ; $t = 25^\circ\text{C}$ (113)

g B/l soln.	g C/l soln.	δ_n	δ_d
93.8597	0	10.26	21.79
0	11.5253	1.57	6.60
1 Vol. B + 2 Vol. C		3.93	11.87

561. B = $\text{C}_4\text{H}_6\text{O}_4$, Succinic acid; C = MoO_3 ; $t = 25^\circ\text{C}$ (113)

g B/l soln.	g C/l soln.	δ_n	δ_d
45.8425	0	4.30	10.77
0	1.3131	-0.28	-1.86
1 Vol. B + 2 Vol. C		1.26	2.37

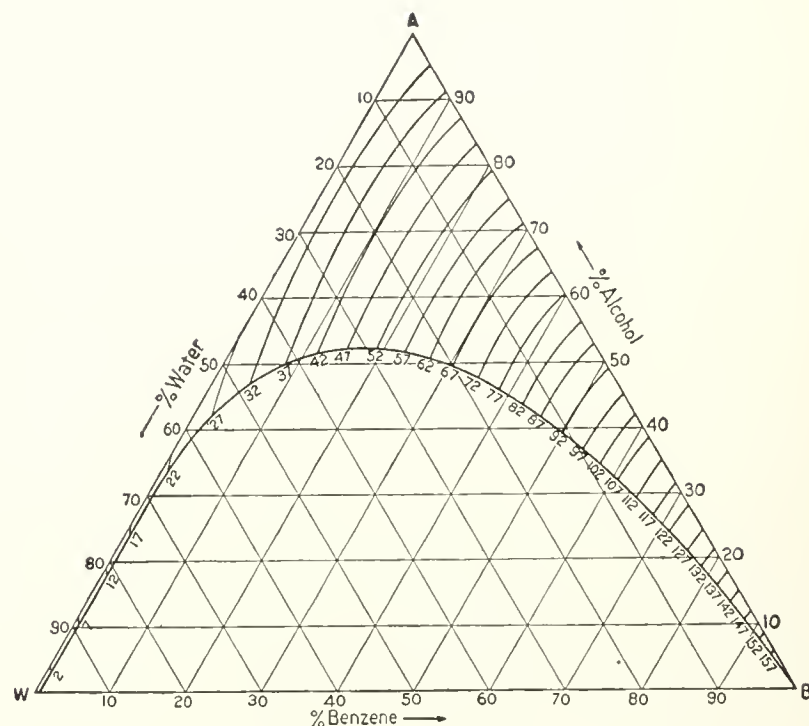


FIG. 1.—Refractivity of system 557; Water (H_2O), Ethyl alcohol ($\text{C}_2\text{H}_5\text{O}$), and Benzene (C_6H_6).

Coordinates are Wt. %; on curve are values of δ_n , $1000n_D^{25} = 1333 + \delta_n$. Below the curve the system is heterogeneous; see 557, Table 2.

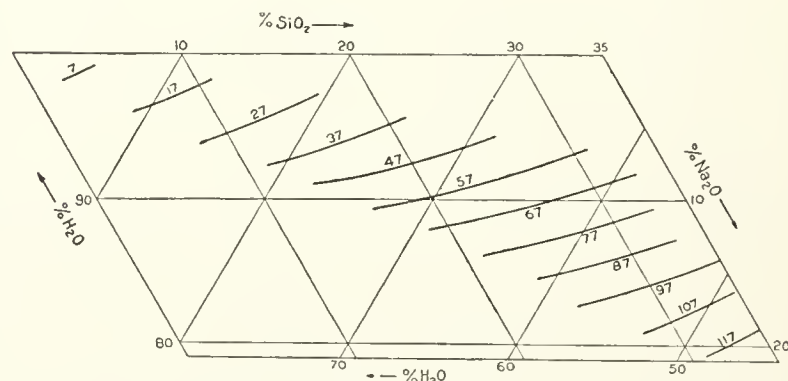


FIG. 2.—Refractivity of system 570; $\text{H}_2\text{O} + \text{SiO}_2 + \text{Na}_2\text{O}$ (145).

Coordinates are Wt. %; on curves are values of δ_n , $1000n_D = 1333 + \delta_n \pm 1$. Neither t nor λ recorded, but λ is obviously D . See 570, Table 2.

562. B = $\text{C}_4\text{H}_6\text{O}_5$, Malic acid; C = MoO_3 ; $t = 25^\circ\text{C}$ (113)

g B/l soln.	g C/l soln.	δ_n	δ_d
168.079	0	18.56	57.82
0	11.8732	1.72	7.21
1 Vol. B + 2 Vol. C		7.38	24.42

563. B = $\text{C}_4\text{H}_6\text{O}_6$, Tartaric acid; C = MoO_3 ; $t = 25^\circ\text{C}$ (113)

g B/l soln.	g C/l soln.	δ_n	δ_d
73.6565	0	8.45	20.69
0	22.3675	3.49	15.54
1 Vol. B + 1 Vol. C		6.30	22.80

564. B = $\text{C}_4\text{H}_6\text{O}_6$, Tartaric acid; C = $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}$; $t = 25^\circ\text{C}$ (113)

g B/l soln.	g C/l soln.	δ_n	δ_d
200.00	0	23.26	84.40
0	200.00	32.19	135.60
2 Vol. B + 1 Vol. C		29.29	109.27

565. B = $\text{C}_6\text{H}_8\text{O}_7$, Citric acid; C = MoO_3 ; $t = 25^\circ\text{C}$ (113)

g B/l soln.	g C/l soln.	δ_n	δ_d
89.8126	0	9.53	30.39
0	11.5253	1.57	6.60
1 Vol. B + 2 Vol. C		4.37	14.72

566. B = C₆H₈O₇, Citric acid, M_B = 2.0; C = NaOH, M_C = 2.0;
 $t = 15^\circ\text{C}$ (28)

Vol. % B	n_D^t	Vol. % B	n_D^t
0.0	1.3535	50.0	1.3625
10.0	1.3539	60.0	1.3659
15.0	1.3541	70.0	1.3694
20.0	1.3543	80.0	1.3729
25.0	1.3545	90.0	1.3763
30.0	1.3561	100.0	1.3800
40.0	1.3592		

567. B = C₇H₁₂O₆, Quinic acid; C = MoO₃; $t = 25^\circ\text{C}$ (113)

g B/l soln.	g C/l soln.	δ_n	δ_d
53.8721	0	7.27	17.22
0	5.49045	0.47	1.46
1 Vol. B + 2 Vol. C		2.92	6.82

568. B = C₈H₈O₂, Phenylacetic acid; C = MoO₃; $t = 25^\circ\text{C}$ (113)

5.8743	0	+0.57	-2.00
0	1.0030	-0.33	-2.09
2 Vol. B + 1 Vol. C		+0.27	-2.02

569. B = C₈H₈O₃, Phenylglycolic acid; C = MoO₃; $t = 25^\circ\text{C}$
 (113)

84.7143	0	14.83	17.04
0	9.4047	1.26	4.41
1 Vol. B + 2 Vol. C		6.14	9.34

570. B = SiO₂; C = Na₂O; see Fig. 2; commercial sodium silicate* (145)

% B	% C	n	d
$x(\text{Na}_2\text{O} + 1.69\text{SiO}_2)$			
1.05	0.64	1.3358	1.0161
3.13	1.90	1.3425	1.0584
6.65	4.04	1.3550	1.1069
9.90	6.02	1.3651	1.1637
13.34	8.10	1.3770	
16.70	10.14	1.3886	1.2970
19.82	12.04	1.4010	1.3705
21.40	13.00	1.4077	1.4037
22.94	13.93	1.4127	1.4414
23.81	14.46	1.4157	1.4646
24.70	15.00	1.4188	
25.69	15.60	1.4235	
26.51	16.10	1.4264	
28.23	17.14	1.4337	
29.69	18.03	1.4390	
31.58	19.18	1.4473	
32.58	19.78	1.4473†	
$x(\text{Na}_2\text{O} + 2.06\text{SiO}_2)$			
2.96	1.48	1.3399	
5.98	2.99	1.3484	1.0829
9.00	4.50	1.3570	1.1328
12.12	6.06	1.3651	1.1789
15.32	7.66	1.3740	
16.86	8.43	1.3787	1.2664
18.76	9.38	1.3850	1.3028

570.—(Continued)

% B	% C	n	d
$x(\text{Na}_2\text{O} + 2.06\text{SiO}_2)$ —(Continued)			
21.06	10.53	1.3916	1.3426
22.24	11.12	1.3972	1.3653
23.10	11.55	1.3984	1.3849
24.02	12.01	1.4016	1.4023
24.86	12.43	1.4043	1.4188
25.78	12.89	1.4090	1.4428
26.60	13.30	1.4122	
29.60	14.80	1.4222	
$x(\text{Na}_2\text{O} + 2.40\text{SiO}_2)$			
1.21	0.52	1.3359	1.0147
2.41	1.03	1.3388	1.0313
7.06	3.02	1.3495	1.0935
11.66	4.99	1.3610	1.1600
$x(\text{Na}_2\text{O} + 2.44\text{SiO}_2)$			
16.68	7.04	1.3734	
19.64	8.29	1.3823	1.2866
21.92	9.25	1.3883	1.3266
24.17	10.20	1.3948	1.3783
25.64	10.82	1.4009	1.3969
27.00	11.40	1.4059	1.4230
28.39	11.98	1.4100	1.4529
29.43	12.42	1.4142	
30.64	12.93	1.4176	
31.65	13.36	1.4219	
32.89	13.88	1.4247	
$x(\text{Na}_2\text{O} + 3.36\text{SiO}_2)$			
1.80	0.55	1.3368	1.0183
3.36	1.03	1.3403	
6.72	2.06	1.3470	1.0733
9.89	3.03	1.3529	1.1137
13.15	4.03	1.3609	1.1499
16.58	5.08	1.3671	1.1934
19.49	5.97	1.3733	1.2404
21.18	6.49	1.3777	1.2653
22.46	6.88	1.3809	1.2839
24.38	7.47	1.3860	1.3170
26.24	8.04	1.3905	1.3476
27.74	8.50	1.3944	1.3692
29.76	9.12	1.3997	1.4078
$x(\text{Na}_2\text{O} + 3.90\text{SiO}_2)$			
1.86	0.49	1.3367	1.0190
3.75	0.99	1.3400	1.0394
5.69	1.50	1.3430	1.0584
7.55	1.99	1.3466	1.0781
9.41	2.48	1.3501	1.0985
11.34	2.99	1.3538	1.1206
13.31	3.51	1.3570	1.1435
14.98	3.95	1.3614	1.1656
17.7†	4.64	1.3666	
20.82	5.49	1.3718	
21.96	5.79	1.3735	
22.99	6.06	1.3774	
23.89	6.30	1.3793	
24.28	6.40	1.3800	
24.54	6.47	1.3807	
25.11	6.62	1.3814	1.3028
25.75	6.79	1.3840	1.3063
26.21	6.91	1.3844	
26.59	7.01	1.3855	

* Impurities, computed as metallic oxides, = 1 % of (Na₂O + ySiO₂) content. Neither t nor λ is recorded, but λ is obviously D ; accuracy in d and n is probably not greater than ± 0.001 .

† 1.4493(?). ‡ 17.6(?)

571. B = HgI₂; C = BaI₂, Rohrbach's solution* (87); 100 g BaI₂ + 130 g HgI₂ + xH₂O

d_4^{20}	n_D^{20}	d_4^{20}	n_D^{20}
2.067	1.5148	3.046	1.6944
2.163	1.5320	3.180	1.7195
2.367	1.5685	3.246	1.7312
2.648	1.6205	3.396	1.7590
2.649†	1.6207†	3.449	1.7656
2.748	1.6391	±0.0015	±0.00015
2.980	1.6823		

($\delta d/\delta t$)₂₀ = +0.0005. If 2.00 < d^{20} < 2.25, $d^{20} = 5.70n_D^{20} - 6.567$; 2.25 < d^{20} < 3.40, $d^{20} = 5.39n_D^{20} - 6.0865$; 3.40 < d^{20} < 3.50, $d^{20} = 5.52n_D^{20} - 6.313$.

* For determining density of minerals; 100 g BaI₂, 130 g HgI₂, and 20 cm³ H₂O are rapidly mixed and heated to boiling point on an oil-bath, then diluted as desired.

† For quartz (SiO₂), $d_4^{20} = 2.6495$, $n_D^{20} = 1.6208$.

572. B = HgCl₂, N = 0.2; C = KCl, N = 0.2 (148)

Vol. % B, 18°	Vol. % C, 18°	n_D^{18}
0	1	1.33513
1	0	1.3381
1	1	1.3367
1	2	1.3362
2	1	1.3372

573. B = HgCl₂; C = KI (113)

g B/l soln.	g C/l soln.	δ_n^{25}	δ_d^{25}
54.18	0	4.12	41.66
0	33.20	3.76	20.93
1 Vol. B + 5 Vol. C		4.33	24.69

574. B = HgCl₂; C = KCN (113)

54.18	0	4.12	41.66
0	13.038	0.86	3.50
1 Vol. B + 1 Vol. C		2.52	22.53
54.18	0	4.11	41.53
0	13.038	0.86	3.46
1 Vol. B + 4 Vol. C		1.39	40.77

575. B = AgNO₃; C = LiNO₃ (113)

169.97	0	16.76	136.15
0	69.07	5.00	23.38
1 Vol. B + 1 Vol. C		10.89	79.72

576. B = AgNO₃; C = KCN (113)

169.97	0	16.76	136.15
0	65.19	7.39	31.53
1 Vol. B + 3 Vol. C		9.20	54.64

577. B = MnSO₄; C = Mn(NO₃)₂ (17)

g B/kg A	g C/kg A	n_D^{20}	α
7.5	6.3	1.3371	1.07

578. B = MnSO₄; C = Fe₂(SO₄)₃ (17)

7.5	10.0	1.3391	1.20
7.5	20.1	1.3400	1.20
3.75	20.1	1.3413	1.20

579. B = FeCl₃; C = NiCl₂ (17)

8.3	2.35	1.3419	1.00
8.3	6.5	1.3410	1.00
4.15	6.5	1.3401	1.13

580. B = Fe₂(SO₄)₃; C = Fe(NO₃)₃ (17)

20.1	12.0	1.3427	1.20
------	------	--------	------

580.1. B = Fe(NO₃)₃; C = Co(NO₃)₂ (17)

g B/kg A	g C/kg A	n_D^{20}	α
12.0	4.5	1.3415	1.07
12.0	9.0	1.3408	1.13
6.0	9.0	1.3401	1.13

581. B = CoCl₂; C = CoSO₄ (17)

6.5	7.6	1.3381	1.07
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582. B = CrO₃; C = MoO₃ (113)

g B/l soln., 25°	g C/l soln., 25°	δ_n^{25}	δ_d^{25}
3.59075	0	0.82	0.82
0	12.0844	2.14	8.32
2 Vol. B + 1 Vol. C		1.27	3.37

583. B = Al₂(SO₄)₃; C = K₂SO₄ (113)

68.475	0	14.10	68.88
0	34.872	3.61	24.37
1 Vol. B + 1 Vol. C		8.82	46.57

584. B = NaCl; C = KCl (113)

58.5	0	9.23	37.04
0	74.6	9.08	42.63
1 Vol. B + 1 Vol. C		9.15	39.84

(138)	B	C	% C = 20 - % B	
% B or C	δ_n^{25}	δ_n^{25}	% B	δ_n^{25}
5	8.72	6.31	0	26.92
10	17.21	13.43	4.446	28.90
15	25.93	20.35	9.35	30.72
20	35.29	26.92	12.36	31.99
			20.00	35.29

585. B = KI; C = KCN (113)

g B/l soln., 25°	g C/l soln., 25°	δ_n^{25}	δ_d^{25}
33.00	0	3.76	20.93
0	13.036	0.86	3.50
1 Vol. B + 1 Vol. C		2.31	12.25

II. Non-Aqueous Mixtures; C-Table, the C-Arrangement CCl₄

Carbon tetrachloride

586. B = C₂H₄Br₂, Ethylene bromide; C = C₇H₈, Toluene (129)
(Pulfrich)*; $\delta = (n_D^{25} - 1.460) \times 1000$; see also Fig. 3

% A	δ	% A	δ
% B/% C = 1/9		% B/% C = 3/7	
0.00	34.3	0.00	37.7
9.64	32.4	10.05	35.1
19.79	30.2	20.05	32.7
29.93	27.8	30.57	29.6
39.97	24.9	39.93	26.5
49.97	22.1	50.37	22.7
59.99	18.4	59.84	19.1
69.91	14.3	69.90	14.8
79.93	9.6	79.99	9.5
90.14	4.0	89.51	3.7
% B/% C = 2/8		% B/% C = 4/6	
0.00	36.0	0.00	40.0
10.65	33.5	9.70	37.2
20.09	31.2	19.91	34.3
29.84	28.7	29.89	31.2
40.27	25.5	40.06	27.2
50.41	22.3	49.95	23.5
60.42	18.5	59.99	19.5
70.24	14.2	70.03	14.8
79.93	9.6	79.90	9.6
90.06	3.9	89.60	3.7

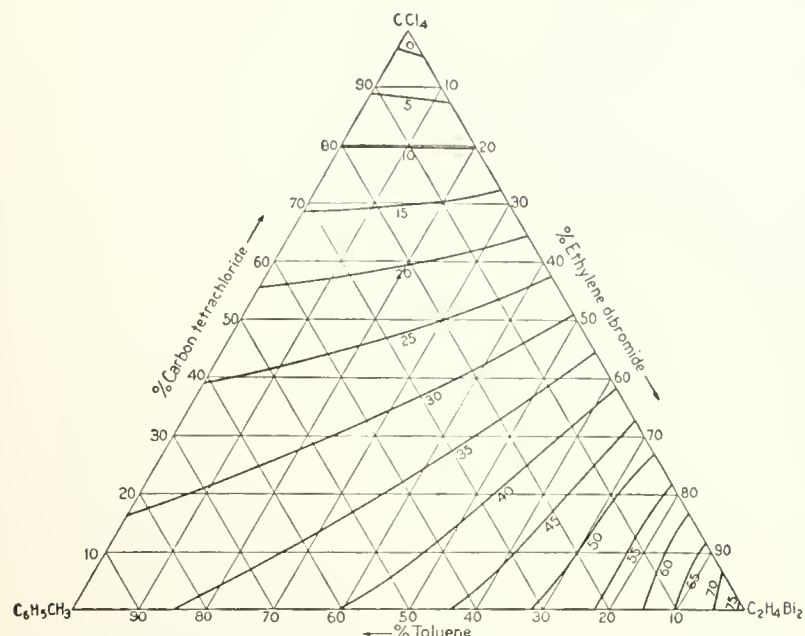


FIG. 3.—Refractivity of system 586; Carbon tetrachloride (CCl_4), Ethylene bromide ($\text{C}_2\text{H}_4\text{Br}_2$), Toluene (C_7H_8) (¹²⁹).

Coordinates are Wt. %; on curves are values of δ , $1000n_D^{25} = 1640 + \delta$; see 586, Table 2.

586.—(Continued)

% A	δ	% A	δ
% B/% C = $\frac{5}{1}$		% B/% C = $\frac{7}{3}$	
0.00	42.7	50.05	25.6
9.87	39.7	60.16	20.7
20.34	35.9	69.95	15.4
29.82	32.8	79.88	9.5
39.87	28.5	89.52	3.6
50.06	24.2	% B/% C = $\frac{8}{2}$	
59.90	19.6	0.00	57.0
69.93	15.0	9.88	51.3
79.95	9.5	20.03	45.2
90.15	3.7	30.47	39.4
% B/% C = $\frac{6}{4}$		40.14	33.5
0.00	46.5	49.93	27.6
9.80	42.7	59.85	21.4
19.91	38.6	69.92	15.5
29.85	34.5	80.11	9.3
40.06	29.9	89.83	3.5
49.94	25.3	% B/% C = $\frac{9}{1}$	
59.87	20.3	0.00	65.0
69.93	15.1	10.21	57.7
79.91	9.6	20.21	50.0
90.06	3.5	29.96	43.0
% B/% C = $\frac{7}{3}$		39.91	36.1
0.00	51.0	50.02	29.0
10.11	46.3	60.15	22.4
19.76	41.5	69.99	15.9
29.71	36.5	80.17	9.4
39.99	31.5	89.95	3.5

586.—(Continued)

% C	0	10	20	30	40	50	60	70	80	90
% A/% B	δ^*									
10	-2.5	+4.2	9.8	14.4	18.4	21.7	24.7	27.2	29.3	31.1
20	+3.4	9.1	13.7	17.5	20.6	23.4	25.9	28.2	29.9	31.5
30	9.6	14.2	17.6	20.7	23.2	25.6	27.4	28.9	30.5	31.7
40	16.3	19.3	22.0	24.0	25.8	27.5	28.9	30.2	31.3	32.0
50	23.4	24.9	26.2	27.5	28.5	29.5	30.3	31.1	31.7	32.3
60	30.6	31.1	31.1	31.3	31.6	31.7	31.9	32.2	32.4	32.7
70	38.8	37.1	35.7	34.9	34.4	33.9	33.5	33.2	33.1	33.0
80	47.3	43.5	40.7	38.6	37.1	35.9	35.1	34.4	33.8	33.3
90	56.6	50.6	45.9	42.6	40.1	38.2	36.7	35.5	34.7	33.6
100	66.7	57.8	51.4	46.8	43.2	40.4	38.4	36.5	35.2	34.1
110	76.3	65.0	57.0	51.0	46.5	42.8	40.0	37.7	36.0	34.3

* Data computed by formula $n^2 = (1.62197)^2 - \sin^2 e$, where e is angle of deviation.



2, 4, 6-Trinitrotoluene

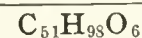
587. B = $\text{C}_7\text{H}_5\text{N}_2\text{O}_4$, 2, 4-Dinitrotoluene; C = $\text{C}_7\text{H}_7\text{NO}_2$, *p*-Nitrotoluene (¹¹); (Abbe) $t = 38$ to 39°C ; presumably *D*-line; approximately eutectic composition (melts *ca.* 17°C); $100n = 1.580(\% \text{ A}) + 1.572(\% \text{ B}) + 1.542(\% \text{ C}) \pm 0.001$.



Palmitic acid

588. B = $\text{C}_{18}\text{H}_{34}\text{O}_2$, Oleic acid; C = $\text{C}_{18}\text{H}_{36}\text{O}_2$, Stearic acid (¹⁰¹); % A = % C = $(100 - \% \text{ B})/2$; $\delta^t = 100(n_D^t - 1.42)$; see Figs. 4, 5, 6.

% A; % C	% B	δ^{60}	δ^{70}	δ^{80}
50.00	0.00	1.52	1.16	0.80
44.30	11.40	1.65	1.29	0.93
38.30	23.40	1.77	1.40	1.03
32.10	35.80	1.87	1.51	1.15
25.55	48.90	2.02	1.65	1.28
20.60	58.80	2.11	1.74	1.37
15.00	70.00	2.25	1.85	1.47
5.00	90.00	2.46	2.05	1.64
0.00	100.00	2.59	2.15	1.71



Tripalmitin

589. B = $\text{C}_{57}\text{H}_{104}\text{O}_6$, Triolein; C = $\text{C}_{57}\text{H}_{110}\text{O}_6$, Tristearin (¹⁰¹); % A = % C = $(100 - \% \text{ B})/2$; $\delta^t = 100(n_D^t - 1.42)$; see Figs. 7, 8, 9.

% A; % C	% B	δ^{60}	δ^{70}	δ^{80}
50.00	0.00	2.45	2.10	1.65
44.79	10.42	2.62	2.22	1.82
39.09	21.82	2.72	2.36	2.00
34.32	31.36	2.80	2.50	2.20
29.46	41.08	2.93	2.61	2.29
24.32	51.36	3.05	2.73	2.41
18.05	63.90	3.19	2.88	2.57
9.95	80.10	3.39	3.07	2.75
4.36	91.28	3.51	3.16	2.81
0.00	100.00	3.61	3.23	2.85
% A	% B	% C	δ^{70}	
71.06	5.25	23.69	2.11	
23.15	7.40	69.45	2.20	
66.56	11.25	22.19	2.21	
21.16	15.36	63.48	2.29	
57.19	23.75	19.06	2.36	
17.46	30.16	52.38	2.49	
41.93	44.10	13.97	2.63	
12.57	49.72	37.71	2.72	

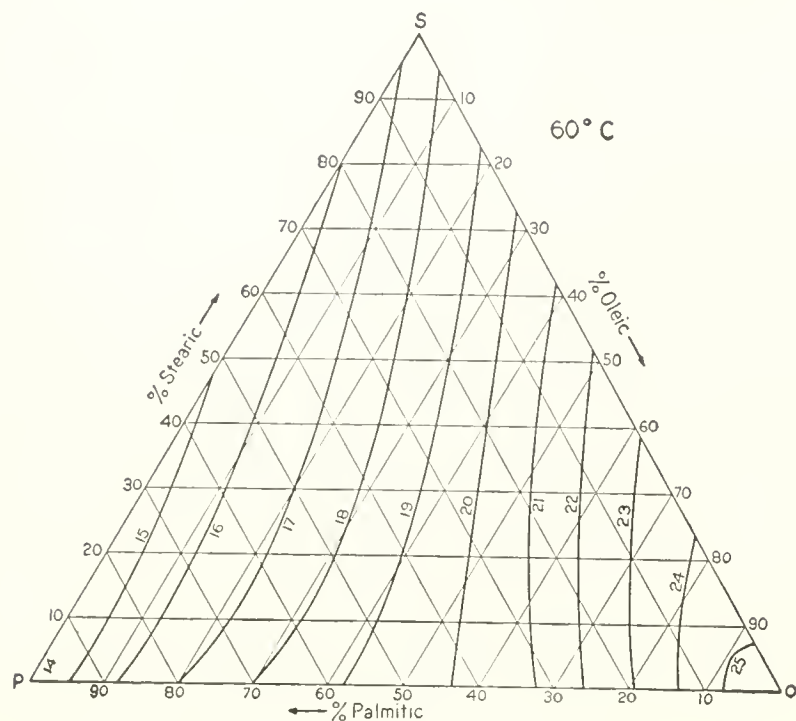


FIG. 4.

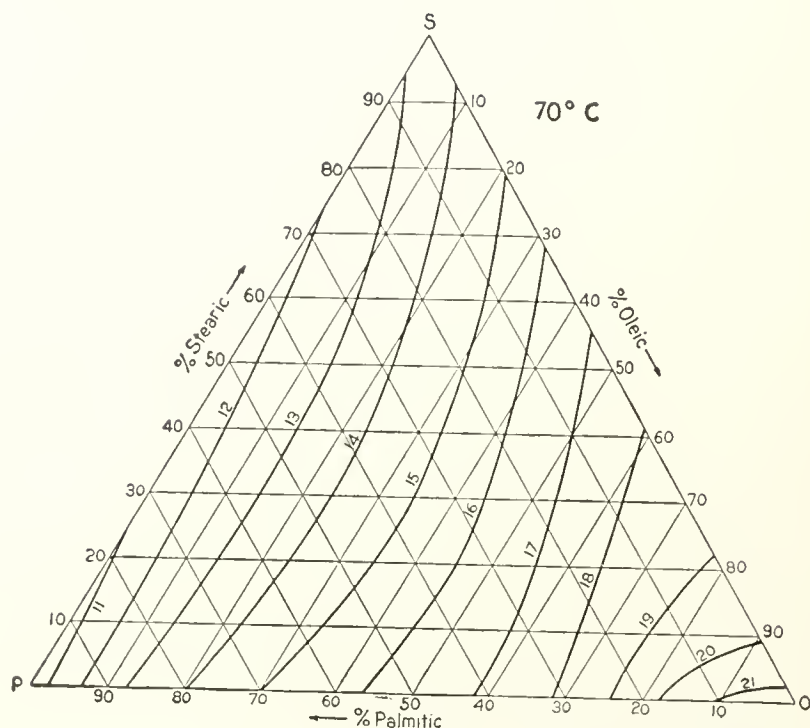


FIG. 5.

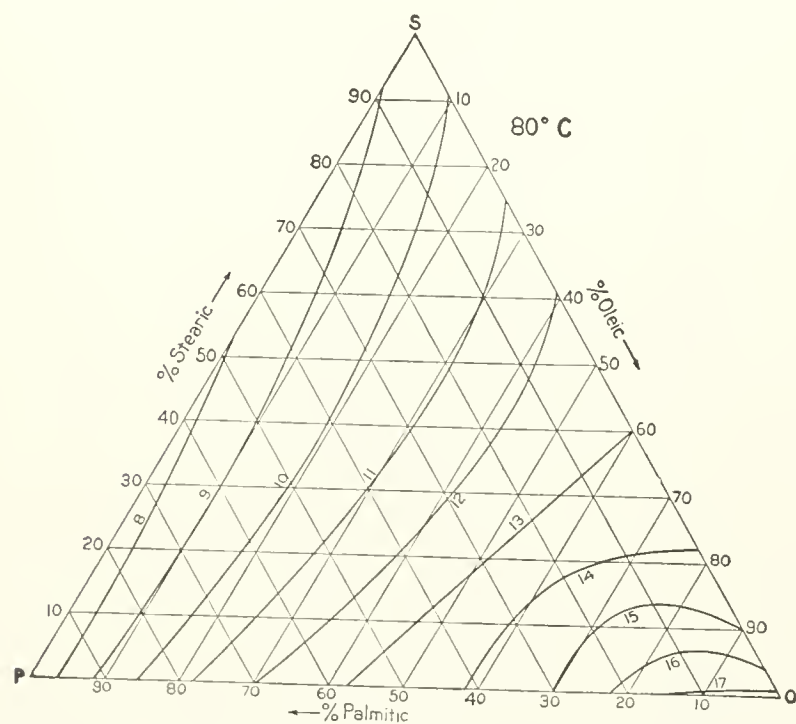


FIG. 6.

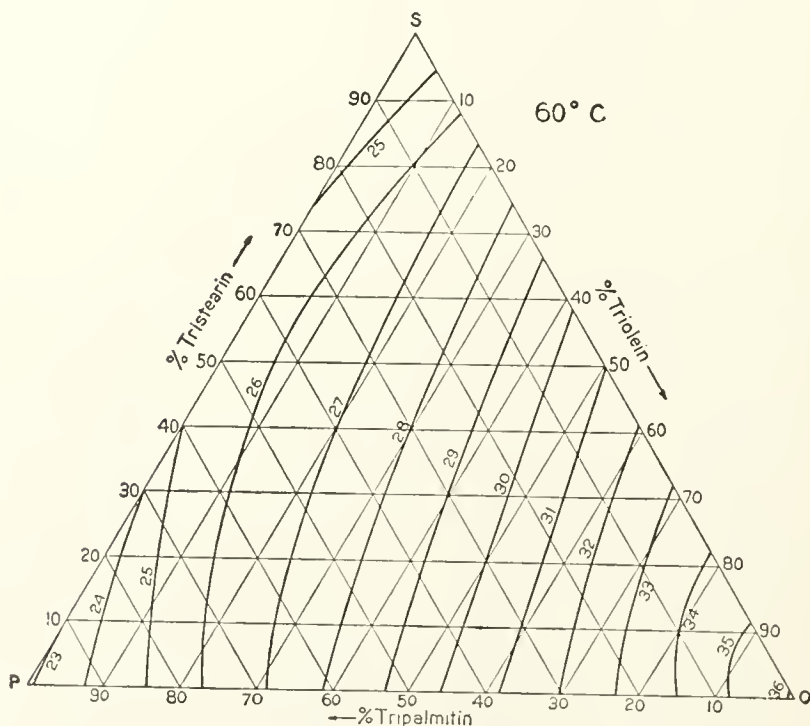


FIG. 7.

FIGS. 4, 5, 6.—Refractivity of system 58S; Palmitic ($C_{16}H_{32}O_2$), Oleic ($C_{18}H_{34}O_2$), and Stearic ($C_{18}H_{36}O_2$) acids (101). Coordinates are Wt. %; on curves are values of δ , $1000n_D^t = 1420 + \delta$; three temperatures, 60, 70, and 80°C; see 58S, Table 2.

TABLE 3.—REFRACTIVITY AT ONE WAVE-LENGTH (D): QUATERNARY AQUEOUS SOLUTIONS (17)
Component A = H_2O ; unit of concentration (C) = 1 g of B(C, D) per 1000 g of A

	B	C	D	C_B	C_C	C_D	n_D^{20}	α_{15}^{30}
590	MnCl ₂	MnSO ₄	Mn(NO ₃) ₂	4.2	5.0	6.0	1.3375	1.20
591	FeCl ₃	Fe ₂ (SO ₄) ₃	Fe(NO ₃) ₃	5.5	13.4	8.0	1.3432	1.20
592	CoCl ₂	CoSO ₄	Co(NO ₃) ₂	4.4	5.1	6.0	1.3382	1.13
593	NiCl ₂	NiSO ₄	Ni(NO ₃) ₂	4.4	5.1	6.1	1.3380	1.13
594	CrCl ₃	Cr ₂ (SO ₄) ₃	Cr(NO ₃) ₃	1.1	2.7	1.6	1.3366	1.07

TABLE 4.—REFRACTIVITY OF SOLUTIONS OF PROTEINS: VARIOUS SOLVENTS

$n_D^t = (n_D^t)_0 + k(10)^{-6}$ (g A/l soln.); $(n_D^t)_0$ = value for solvent; $1000(n_D^t)_0 = 1333 + \delta_0$; 0.4S = 0.4 saturated; for symbols, v. p. 64

t	Solvent				k	Lit.
	B	C	Conc. of C	δ_0		
A = Albumins from ox-blood serum						
24	H ₂ O	(NH ₄) ₂ SO ₄	0 to 0.4S		177 ± 8	(119)
A = Ovalbumen						
22.5	H ₂ O	(NH ₄) ₂ SO ₄	1 %	1.49	177 ± 6	(55)
22.5	H ₂ O	NaOH	$N = 0.1$	0.98	177 ± 6	(55)
23	H ₂ O	NaOH	$N = 0.05$ to 0.005		177 ± 6	(55)

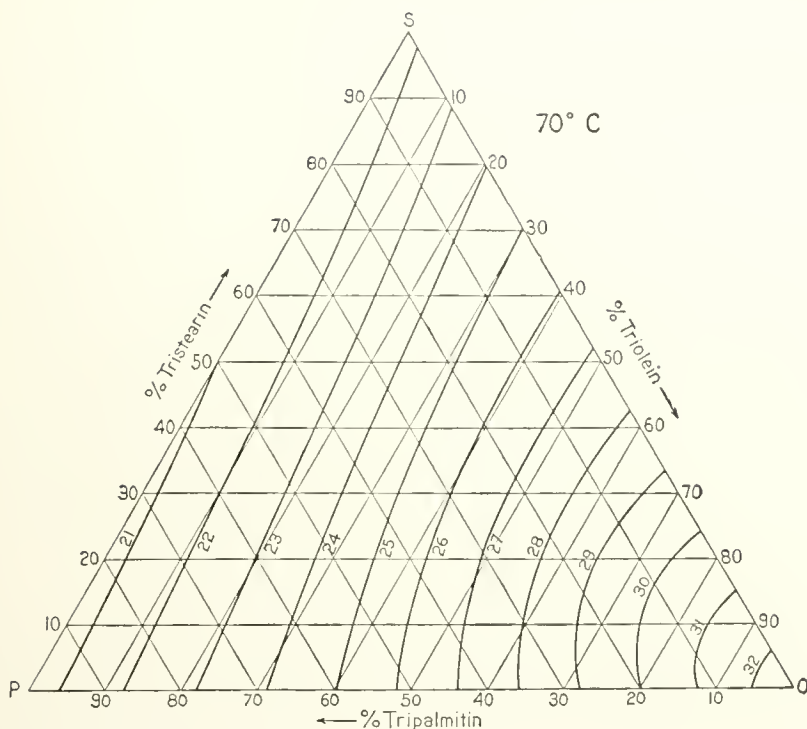


FIG. 8.

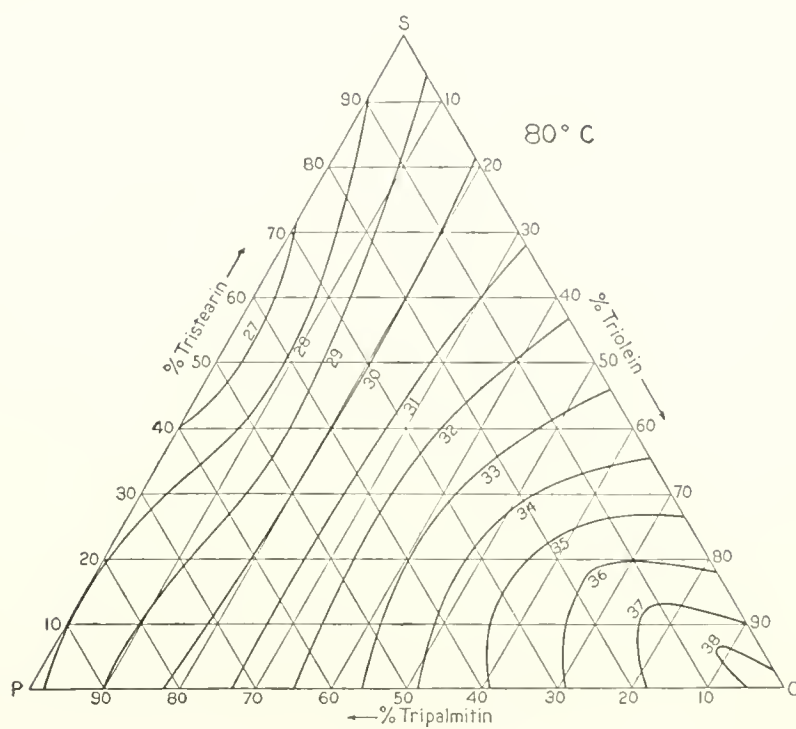


FIG. 9.

FIGS. 7, 8, 9.—Refractivity of system 589; Tripalmitin ($C_{51}H_{98}O_6$), Triolein ($C_{57}H_{104}O_6$), and Tristearin ($C_{57}H_{110}O_6$) (101). Coordinates are Wt. %; on curves are values of δ , $1000n_D' = 1420 + \delta$; three temperatures, 60, 70, and 80°C; see 589, Table 2.

TABLE 4.—(Continued)

<i>t</i>	Solvent				<i>k</i>	Lit.
	B	C	Conc. of C	δ_0		
A = Casein						
20 to 40	H ₂ O	Ac., Al.*	†		152	(114)
25	H ₂ O	KOH	<i>N</i> = 0.025	− 1.30	149 ± 4	(118)
25	25 % C ₂ H ₅ OH†	KOH	<i>N</i> = 0.025	+12.27	157 ± 5	(118)
25	50 % C ₂ H ₅ OH†	KOH	<i>N</i> = 0.025	+23.50	149 ± 5	(118)
25	75 % C ₂ H ₅ OH†	KOH	<i>N</i> = 0.025	29.26	125 ± 6	(118)
A = Edestin						
16 to 26	H ₂ O	Ac., Al., S.*	†		174 ± 6	(126)
A = Gliadin from wheat						
20	H ₂ O	KOH	<i>N</i> = 0.1	2.37	167 ± 6	(122)
25	H ₂ O	C ₂ H ₄ O ₂ ‡	<i>N</i> = 0.1	1.26	161 ± 6	(122)
25	H ₂ O	C ₂ H ₅ OH‡	60 Vol. %	28.90	143 ± 6	(122)
25	H ₂ O	C ₂ H ₅ OH‡	70 Vol. %	31.50	152 ± 6	(122)
25	H ₂ O	C ₃ H ₆ O‡	25 Vol. %	15.21	168 ± 6	(122)
25	H ₂ O	C ₃ H ₆ O‡	50 Vol. %	27.82	147 ± 6	(122)
25	H ₂ O	C ₃ H ₇ OH‡	60 Vol. %	38.70	152 ± 6	(122)
25	H ₂ O	C ₆ H ₆ O‡	75 %	163.49	−38 ± 6	(122)
A = Globin from ox-blood						
18	H ₂ O	Ac., Al.*	<i>N</i> = 0.1		169 ± 5	(121)
A = Globin caseinate						
16	H ₂ O	KOH	<i>N</i> = 0.1	2.52	162 ± 5	(121)
A = Hemoglobin from horse						
19.5§	H ₂ O	NH ₃	<i>N</i> = 0.1	1.1	183 ± 1	(69)
A = Serum globulin from ox						
23	H ₂ O	Ac., Al.*			229	(117)
23	25 % C ₂ H ₅ OH†	KOH	<i>N</i> = 0.025	12.78	202	(117)
23	50 % C ₂ H ₅ OH†	KOH	<i>N</i> = 0.025	24.29	119	(117)
23	25 % C ₃ H ₆ O‡	KOH	<i>N</i> = 0.025	13.69	227	(117)
19	50 % C ₃ H ₆ O‡	KOH	<i>N</i> = 0.025	26.84	146	(117)
A = Ovomucoid						
18	H ₂ O		0	0.3	160	(115)
A = Ovovitellin						
18	H ₂ O	Al*			130	(115)
A = Paraneuclein						
22	H ₂ O	Al.*			140	(116)
A = Protein: Total from ox-blood serum						
20	H ₂ O	KOH	<i>N</i> = 0.01		195 ± 2	(119)
A = Serum of ox-blood						
20	H ₂ O		0		195 ± 2	(119)
A = Salamine sulfate¶						
22	H ₂ O		0	1.10	174 ± 7	(3)

TABLE 4.—(Continued)

<i>t</i>	Solvent				<i>k</i>	Lit.
	B	C	Conc. of C	δ_0		
A = Salamine chloride [¶]						
18	H ₂ O		0	0.56	172 ± 16	(3)

* Ac., Al., S. = acids, alkalies, salts. † Various concentrations.
‡ C₂H₄O₂ = acetic acid; C₂H₅OH = ethyl alcohol; C₃H₆O = acetone;
C₃H₇OH = *n*-propyl alcohol; C₆H₆O = phenol.
§ Same value for *t* = 19 to 21°C. || Dilute. ¶ From prolamine from Pacific salmon.

TABLE 5.—SPECTRAL DISPERSION OF MIXTURES

For index of refraction at one wave-length, see Table 1 or 2; for formula index of substances, see Table 1; for order of arrangement, see Vol. III, p. viii. Each mixture has the same index number as in Table 1 or 2.

The tabular values $\left(\frac{\lambda_1}{\lambda_2}\right)$ represent differences in *n*; $n_{\lambda_2} = n_{\lambda_1} + \left(\frac{\lambda_1}{\lambda_2}\right) \times 10^{-5}$; the average dispersion between λ_1 and λ_2 is $\frac{n_{\lambda_2} - n_{\lambda_1}}{\lambda_1 - \lambda_2} = \left(\frac{\lambda_1}{\lambda_2}\right) \times \frac{10^{-5}}{(\lambda_1 - \lambda_2)}$ per unit of λ . The symbol expressing the concentration always refers to constituent B unless another is indicated.

By combining the differences given in this table with the value of *n* (for C, D, 5876, F, or 3256) for the same author, as given in Table 1 or 2, his values of *n* for other values of λ are obtained. Unit of λ = 1 Å = 10^{−8} cm. *t* = centigrade temperature, °C.

I. Two-Component Aqueous Mixtures; Standard Arrangement

Only authorities (38, 65, 85, 86) have recorded the refraction and the dispersion of the H₂O used in making the solution, as follows:

$$(38) \quad t = 15^\circ\text{C}, \quad n_D' = 1.33345, \quad \left(\frac{6708}{5893}\right) = 219, \quad \left(\frac{5893}{5351}\right) = 186;$$

$$(65) \quad t = 18^\circ\text{C}, \quad n_{3256}' = 1.35326, \quad \left(\frac{4679}{3256}\right) = 1491, \quad \left(\frac{3612}{3256}\right) = 568,$$

$\left(\frac{3405}{3256}\right) = 262$, $\left(\frac{3256}{2981}\right) = 624$, $\left(\frac{3256}{2749}\right) = 1332$, $\left(\frac{3256}{2574}\right) = 2040$,
 $\left(\frac{3256}{2314}\right) = 3576$; $(^{85})$ $t = 70^\circ\text{C}$, $n_D^t = 1.32522$, $\left(\frac{C}{D}\right) = 175$,
 $\left(\frac{D}{F}\right) = 431$; $(^{86})$ $t = 18^\circ\text{C}$, $n_D^t = 1.33322$, $\left(\frac{C}{D}\right) = 183$, $\left(\frac{D}{F}\right) =$
 415 , $\left(\frac{F}{G'}\right) = 323$.

7. B = H_2SO_4 , 95 to 96% H_2SO_4 ; electrically heated SiO_2 prism, indices corrected to air at 20°C and 1 atm $(^{15})$

t	$\left(\frac{5893}{5780}\right)$	$\left(\frac{5893}{4358}\right)$
28.4*	5#	80#
49.1	3#	79#
85.8	4#	75#
113.8	4#	75#
173.9	6#	76#
206.8	4#	71#
264.2	6#	70#
307.5	3#	71#

t	$\left(\frac{5893}{4341}\right)$	$\left(\frac{5893}{4047}\right)$
28.4*	81#	106#
49.1	81#	105#
85.8	77#	102#
113.8	78#	102#
173.9	77#	99#†
206.8	74#	97#
264.2	71#	91#
307.5	72#	93#

* At 28.4° , $\left(\frac{6708}{5893}\right) = 27\#$, $\left(\frac{5893}{4861}\right) = \left(\frac{D}{F}\right) = 47\#$.

† Assumes $n_{4047} = 1.4023$ instead of 1.4923.

28. B = $\text{C}_2\text{H}_5\text{O}$, Ethyl alcohol $(^{38})$; $t = 15^\circ\text{C}$; for all values of
 $\% \text{B}$, $\left(\frac{6708}{5893}\right) = 221 \pm 6$, $\left(\frac{5893}{5351}\right) = 185 \pm 6$

45. B = $\text{C}_6\text{H}_4\text{O}_2$, 2-Furaldehyde $(^{132})$

$\% \text{B}$	$\left(\frac{6563}{5876}\right)$	$\left(\frac{5876}{4861}\right)$	t
4.6217	213	480	24.05
	212	474	37.85
5.6935	219	496	23.8
	219	496	35.4
6.5624	224	502	21.75
	224	503	31.85
96.3400	719	1912	23.7
	714		30.3
100.000	744	1971	22.1
	735	1954	32.3
	729	2031	46.5
	700	1973	75.0

67. B = $\text{Pb}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	195	355	443
1.0	209	372	478
2.0	235	535	

68. B = $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$, Acetate; $t = 18^\circ\text{C}$ $(^{65})$

N	$\left(\frac{4679}{3256}\right)$	$\left(\frac{3612}{3256}\right)$
0.4971	1611	618
0.9725	1741	726
2.006	2004	790
N	$\left(\frac{3405}{3256}\right)$	$\left(\frac{3256}{2981}\right)$
0.4971	288	731
0.9725	313	760
2.006	368	914

73. B = CdCl_2 (Pulfrich); $t = 25^\circ\text{C}$ $(^{49})$

$\% \text{B}$	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$
1.599	192	418
4.472	174	432
8.620	207	436
11.600	230	434
18.690	206	505
21.201	218	493
26.076	219	530
31.090	244	548
41.540	274	623

76. B = CdBr_2 (Pulfrich); $t = 25^\circ\text{C}$ $(^{49})$

1.05	287	561
2.76	193	415
5.41	167	457
11.03	183	465
15.66	192	508
21.13	212	540
27.51	243	560
40.74	243	690

77. B = CdI_2 (Pulfrich); $t = 25^\circ\text{C}$ $(^{49})$

0.834	182	436
3.340	166	437
3.880	233	413
6.984	207	471
13.491	209	448
20.133	268	572
26.785	286	669
39.860	306	848

79. B = HgCl_2 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.3	186	417	339
0.5	190	433	336

80. B = $\text{Cu}(\text{ClO}_3)_2$; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	189	431	340
1	192	444	350
2		448	378

81. B = $\text{Cu}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	193	438	341
1	202	457	362
2		499	402

84. B = MnCl_2 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	189	429	336
1	194	445	351
2	206	471	382
6	249	583	475

N $(^{65})$	$\left(\frac{4679}{3256}\right)$	$\left(\frac{3612}{3256}\right)$
0.4995	1546	591
1.013	1625	616
2.024	1738	665
4.042	1968	753

N $(^{65})$	$\left(\frac{3405}{3256}\right)$	$\left(\frac{3256}{2981}\right)$
0.4995	273	652
1.013	284	682
2.024	308	735
4.042	352	841

N $(^{65})$	$\left(\frac{3256}{2749}\right)$	$\left(\frac{3256}{2574}\right)$
0.4995	1395	2142
1.013	1461	2244
2.024	1583	2441
4.042	1815	2816

N $(^{65})$	$\left(\frac{3256}{2314}\right)$
0.4995	3769
1.013	3966
2.024	4336
4.042	4998

85. B = MnBr_2 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	193	444	348
1	204	470	377
2	225	522	422
4	263	633	506

87. B = $\text{Mn}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	190	434	339
1	198	453	355
2	214	482	403

88. B = FeCl_2 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	189	435	332
1	196	457	
2	183	524	
4	183	610	

89. B = FeCl_3 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	196	447	
1	209	480	
2	235	560	
4	293		

90. B = FeBr_2 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	195	444	351
1	206	472	373
2	231	529	
4	271	631	
5	296	689	

92. B = $\text{Fe}(\text{NO}_3)_3$; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	196	450	
1	207	479	
2	232	535	
4	282	654	

93. B = CoCl_2 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	193	433	340
1	199	450	351
2	211		
4	234		

94. B = $\text{Co}(\text{ClO}_3)_2$; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	189	426	330
1	192	431	342
2	201	449	358
4	218		
5	235		

95. B = CoBr_2 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	194	444	345
1	208	472	368
2	228	526	410
4	273		

97. B = $\text{Co}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	189	431	344
1	196	447	357
2	211		
4	239		
5	243		

98. B = NiCl_2 ; $t = 18^\circ\text{C}$ $(^{86})$

N	$\left(\frac{C}{D}\right)$	$\left(\frac{D}{F}\right)$	$\left(\frac{F}{G'}\right)$
0.5	189	434	340
1	197	450	
2		493	
4		545	

N $(^{65})$	$\left(\frac{4679}{3256}\right)$	$\left(\frac{3405}{3256}\right)$
0.4960	1555	274
1.002	1622	286
2.037	1752	311
4.014	2021	359

N $(^{65})$	$\left(\frac{3256}{2981}\right)$	$\left(\frac{3256}{2749}\right)$
0.4960	655	1400
1.002	684	1470
2.037	744	1603
4.014	848	1852

98.—(Continued)

N (65)	(3256) (2574)	(3256) (2314)
0.4960	2149	3784
1.002	2260	3991
2.037	2471	4391
4.014	2878	

99. B = $\text{Ni}(\text{ClO}_3)_2$; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	189	426	330
1	190	436	340
2	197	456	
4		502	

99.1. B = NiBr_2 ; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	196	443	346
1	205	473	376
2	225	530	
4		656	

101. B = $\text{Ni}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	190	433	336
1	197	451	
2		488	
4		560	
6		631	

102. B = CrCl_3 ; $t = 18^\circ\text{C}$ (86)

N	(C) (D)	(D) (F)	(F) (G')
0.3	197	416	307
0.5	189	434	
1	199	454	
2	215	500	

103. B = CrBr_3 ; $t = 18^\circ\text{C}$ (86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	194	450	
1	207	578	
2	224	554	

110. B = AlCl_3 ; $t = 18^\circ\text{C}$ (86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	188	431	333
1	194	444	345
2	204	473	370
4	225	534	406

112. B = $\text{Al}(\text{NO}_3)_3$; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	189	433	335
1	196	449	350
2	207	483	375
4	232	547	436
6	257	608	488

114. B = BeCl_2 ; $t = 18^\circ\text{C}$ (86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	187	427	331
1	191	440	339
2	200	464	356
4	214	513	394

115. B = $\text{Be}(\text{NO}_3)_2$; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	189	428	337
1	195	443	351
2	205	474	373
4	225	532	423

122. B = MgCrO_4 ; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	213		
1	240		
2	296		
4	401		
5	464		

145. B = LiClO_3 ; $t = 18^\circ\text{C}$

N (65)	(4679) (3256)	(3612) (3256)
0.5124	1518	579
1.023	1544	587
2.043	1567	580
4.090	1697	648
N (65)	(3405) (3256)	(3256) (2981)
0.5124	264	635
1.023	270	646
2.043	249	699
4.090	299	701
N (65)	(3256) (2749)	(3256) (2574)
0.5124	1359	2081
1.023	1386	2123
2.043	1463	2228
4.090	1531	2352

149. B = Li_2SO_4 ; $t = 18^\circ\text{C}$ (65)

N	(4679) (3256)	(3612) (3256)
0.4307	1507	576
0.871	1514	578
1.744	1532	582
3.493	1568	597
N	(3405) (3256)	(3256) (2981)
0.4307	265	631
0.871	266	638
1.744	268	643
3.493	275	655
N	(3256) (2749)	(3256) (2574)
0.4307	1343	2057
0.871	1351	2071
1.744	1370	2092
3.493	1398	2134

 $t = 18^\circ\text{C}$ (86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	185	420	329
1	186	425	333
2	191	432	340
4	199	440	344

151. B = $\text{LiC}_2\text{H}_3\text{O}_2$, Acetate;
 $t = 18^\circ\text{C}$ (65)

N	(4679) (3256)	(3612) (3256)
0.4885	1529	584
1.047	1571	600
2.022	1741	420
4.033	1791	681

151.—(Continued)

N	(3405) (3256)	(3256) (2981)
0.4885	269	642
1.047	278	661
2.022	291	699
4.033	314	761
N	(3256) (2749)	(3256) (2574)
0.4885	1385	2116
1.047	1418	2201
2.022	1499	2332
4.033	1634	2588

152. B = LiCNS ; $t = 18^\circ\text{C}$ (65)

N	(4679) (3256)	(3612) (3256)
0.5109	1646	631
1.031	1796	696
2.082	2105	824
3.465	2514	983
N	(3405) (3256)	(3256) (2981)
0.5109	293	703
1.031	321	783
2.082	383	941
3.465	464	1115
N	(3256) (2746)	
0.5109	1525	
1.031	1716	
2.082	2081	
3.465	2497	

153. B = Li_2CrO_4 ; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)
0.5	210	512
1	238	
2	292	
4	402	

154. B = $\text{Li}_2\text{Cr}_2\text{O}_7$; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)
0.3	207	
0.5	224	
1	267	

181. B = $\text{NaC}_{16}\text{H}_{31}\text{O}_2$, Palmi-
tate; $t = 70^\circ\text{C}$ (85)

N	(C) (D)	(D) (F)
0.5	195	467
1	210	519
2	238	620

N	(C) (D)	(D) (F)
0.5	185	420
1	186	425
2	191	432
4	199	440

Purified commercial material

N	(C) (D)	(D) (F)
28.9	214	400
33.7	180	406
45.2	183	420
52.3	186	404
64.7	189	418
72.1	178	416
86.8	171	426

182. B = $\text{NaC}_{18}\text{H}_{33}\text{O}_2$, Oleate;
 $t = 70^\circ\text{C}$ (85)

N	(C) (D)	(D) (F)
0.0	175	431
38.8	200	413
49.7	188	425
69.2	181	426
100.4	182	381
126.8	189	431
149.0	213	430
177.5	246	408

183. B = $\text{NaC}_{18}\text{H}_{35}\text{O}_2$, Stearate;
 $t = 70^\circ\text{C}$ (85)

N	(C) (D)	(D) (F)
0.0	175	431
24.2	170	400
28.4	176	407
35.7	177	422
44.9	184	400

191. B = Na_2CrO_4 ; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.3	201	470	
0.5	213		
1	242		
2	296		

193. B = KCl ; $t = 18^\circ\text{C}$
(Abbe) (14)

N	(C) (D)	(D) (F)	(F) (G')
1	19#	44#	33#
2	20#	47#	35#
3	20#	48#	38#

209. B = $\text{KC}_{16}\text{H}_{31}\text{O}_2$, Palmi-
tate; $t = 70^\circ\text{C}$ (85)

N	(C) (D)	(D) (F)
0.0	175	431
33	174	420
38.2	179	416
47.3	166	417
56.2	170	425
66.3	162	419
75.7	161	436
91.5	180	419

217. B = $\text{K}_3\text{Fe}(\text{CN})_6$; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	195	467	
1	210	519	
2	238	620	

218. B = $\text{K}_4\text{Fe}(\text{CN})_6$; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.5	194	447	345
1	204	480	361
2	227	525	404

219. B = K_2CrO_4 ; $t = 18^\circ\text{C}$
(86)

N	(C) (D)	(D) (F)	(F) (G')
0.3	201	474	
0.5	213	513	
1	242		
2	292		
4	397		

220. B = $\text{K}_2\text{Cr}_2\text{O}_7$; $t = 18^\circ\text{C}$

N	⁽⁸⁶⁾		
	(C) (D)	(D) (F)	(F) (G')
9.3	208		
0.5	224		

227. B = CsBr ; $t = 18^\circ\text{C}$ ⁽⁸⁶⁾

N	(C) (D)	(D) (F)	(F) (G')
0.5	193	442	346
1	203	465	370

227.—(Continued)

N	(C) (D)	(D) (F)	(F) (G')
2	223	514	420
4	263	613	504

228. B = CsNO_3 ; $t = 18^\circ\text{C}$ ⁽⁸⁶⁾

N	(C) (D)	(D) (F)	(F) (G')
0.3	187	424	333
0.5*	190	458	312
1	195	444	352

* $\left(\frac{D}{G'}\right) = 770$.

IIa. Non-Aqueous Binary Mixtures: Inorganic

S

229. B = Se ; t is not stated ⁽⁸⁸⁾

% B	(6708) (5893)	(5893) (5351)	% B	(6708) (5893)	(5893) (5351)
0.0	20##	20##	57.0	48##	57##
9.0	22##	24##	64.0	57##	68##
17.6	25##	29##	70.0	65##	80##
25.0	28##	32##	75.0	73##	
31.8	32##	36##	80.0	90##	
37.5	34##	39##	87.7	124##	
43.2	38##	44##	93.8	155##	
48.2	43##	47##	99.2	200##	
53.0	45##	52##	100	204##	

IIb. Non-Aqueous Binary Mixtures: C-Table, the
C-Arrangement

The A-Component is a C-Compound

 CCl_4

Carbon tetrachloride

232. B = $\text{C}_2\text{H}_4\text{O}_2$, Acetic acid
(137)

% A	(6563) (5893)	(5893) (4961)	(4961) (4358)	t
21.319	209	514	363	13.0
21.319	208	491	375	24.5
21.319	205	492	357	40.3
41.728	236	523	395	13.3
41.728	215	518	386	39.5
41.728	214	507	370	57.0
64.436	214	585	453	14.5
64.436	515*	573	454	22.5
64.436	221	565	442	34.1
100.000	287	700	554	10.7
100.000	283	682	555	23.8
100.000	279	661	549	37.1

* Possibly it should be 215.

 CS_2

Carbon disulfide

237. B = SnCl_4 , Stannic
chloride (135)

% B	(6563) (5876)	(5876) (4861)	(4861) (4341)	t
0.000	961	2455	2285	19.1
0.000	956	2418	2742*	28.3
13.8282	935	2337		25.7
13.8282	908	2276		34.1
27.2410	863	2177		24.9
27.2410	855	2151		34.1
38.6050	821	2055		23.7
38.6050	820	2075		34.1
44.3085	786	1977		24.2
44.3085	759	1971		36.1
66.3864	656	1653		26.2
66.3864	656	1663		35.5
80.7152	586	1459		25.1
80.7152	580	1443		37.4
100.000	368	1102		27.1
100.000	446	1107		42.7

* Surely wrong.

238. B = CHCl_3 , Chloroform
(135)

% B	(6563) (5876)	(5876) (4861)	(4861) (4341)	t
0.000	961	2455	2285	19.1
0.000	956	2418	2742*	28.3
19.1533	839	2163	1906	27.8
19.1533	829	2068	1885	35.7
34.8063	740	1805	1629	26.6
34.8063	703	1786	1622	33.1
50.6210	603	1499	1350	26.1
50.6210	597	1495	1343	36.4
58.9405	550	1346	1200	26.0
58.9405	539	1343		36.5
75.7576	438	1038	913	28.5
75.7576	417	1042	889	33.8
100.000	251	826	514	22.7
100.000	255	610	513	35.4

* Surely wrong.

239. B = $\text{C}_2\text{H}_4\text{O}_2$, Acetic acid
(133, 136)

% B	(6563) (5893)	(5893) (4961)	(4961) (4358)	t
0.000	963	2530	2274	6.8
0.000	940	2486	2256	20.9
0.000	910	2429	2208	34.5
12.076	806	2133		11.9
12.076	788	2108	1900	23.1
12.076	756	2039	1836	44.3
61.284	416	1045	896	13.9
61.284	406	1040	890	21.1
61.284	396	1009	870	35.0
80.298	300	759	601	11.5
80.298	289	735	582	23.0
80.298	292	706	568	41.2
100.000	197	475	331	21.7
100.000	196	471	327	31.7
100.000	196	462	322	49.2

240. B = $\text{C}_2\text{H}_5\text{NO}_3$, Ethyl
nitrate; $t = 15^\circ\text{C}$ ⁽¹⁰⁵⁾

% B	(C) (F)	(F) (G')
0.00	3426	2273
46.73	1956	1260

241. B = $\text{C}_2\text{H}_5\text{O}$, Ethyl
alcohol; $t = 20^\circ\text{C}$ ⁽¹³⁴⁾

% B	(C) (F)	(F) (G')
0.000	3421	2247
20.182	2508	1623
31.966	2085	1328
49.234	1589	1002
100.000	611	350

242. B = $\text{C}_3\text{H}_6\text{O}$, Acetone;
 $t = 25^\circ\text{C}$ ^(70, 71); cf. (152)

% A	(C) (D)	(D) (F)	(F) (G')
0.000	187	476	398
13.245	243	601	524
29.326	317	807	716
40.329	385	966	857
51.761	477	1134	1084
51.799	459	1164	1105
51.902	452	1168	1032
71.137	599	1571	1398
83.283	718	1899	1702
86.892	763	2012	1814
100.000	917	2473	2243

243. B = $\text{C}_3\text{H}_8\text{O}_2$, Methylal;
 $t = 25^\circ\text{C}$ ^(70, 71)

% B	(6563) (5893)	(5893) (4961)	(4961) (4358)	t
0.000	148	407	334	
12.921	225	566	476	
28.682	307	776	685	
38.408	366	926	817	
45.630	410	1049	932	
53.139	463	1193	1064	
60.034	524	1336	1179	
62.38	533	1392	1234	
65.262	559	1458	1246	
75.141	649	1697		
86.449	764	2025	1815	
100.000	917	2473	2243	

244. B = $\text{C}_4\text{H}_8\text{O}_2$, Isobutyric
acid (133, 136)

% B	(6563) (5893)	(5893) (4961)	(4961) (4358)	t
0.000	963	2530	2274	6.8
0.000	940	2486	2256	20.9
0.000	910	2429	2208	34.5
20.336	719	1920	1705	11.75
20.336	726	1884	1703	19.5
20.336	730	1841	1674	34.5
45.276	514	1338	1267	11.2
45.276	495	1326	1256	18.2
45.276	482	1313	1217	30.8
68.028	349	936	914	13.2
68.028	337	945	896	18.4
68.028	344	915	879	38.0
100.000	198	481	504	9.1
100.000	191	473	494	25.9
100.000	184	466	486	39.4
100.000	178	453	466	68.4

245. B = $\text{C}_4\text{H}_{10}\text{O}$, Isobutyl
alcohol (133, 135)

% B	(6563) (5893)	(5893) (4961)	(4961) (4358)	t
15.803	754	1999	1772	9.6
15.803	737	1932	1722	28.9
15.803	725	1903	1703	39.7
30.008	627	1614	1422	8.3
30.008	606	1567	1379	25.2
30.008	607	1552	1376	33.6
50.220	474	1169	1039	11.8
50.220	456	1205	982	22.1
70.388	338	856	742	9.5
70.388	319	840	701	22.4
100.000	180	496	380	23.7
100.000	179	491	376	34.9

246. B = $\text{C}_4\text{H}_{10}\text{O}$, Ethyl ether
(135)

% B	(6563) (5876)	(5876) (4861)	(4861) (4341)	t
0.000	961	2455	2285	19.1
0.000	956	2418	2742*	28.3
20.3505	700	1742	1568	24.0
20.3505	687	1725	1545	30.2
29.6571	606	1495	1352	25.4
29.6571	594	1481	1366	30.3
41.5400	495	1237	1108	24.4
41.5400	501	1236	1075	30.3
59.9864	377	904	783	25.3
59.9864	365	900	773	30.6
79.7398	269	635	561	25.7
100.000	186	422	347	24.8
100.000	186	420	346	29.7

* Surely wrong.

247. B = $\text{C}_5\text{H}_{10}\text{O}_2$, Isovaleric
acid (133, 136)

% B	(6563) (5893)	(5893) (4961)	(4961) (4358)	t
28.295	673	1727	1519	9.5
28.295	637	1680	1513	20.3
28.295	629	1660	1498	32.0
45.900	529	1337	1168	8.0
45.900	508	1308	1151	19.8
45.900	504	1296	1164	26.6
62.573	395	1029	888	11.2
62.573	404	1003	890	20.5
62.573	393	976	856	37.7
100.000	212	495	539	8.1
100.000	204	481	536	28.3
100.000	201	508	488	41.9
100.000	195	491	482	57.0

235. B = C_6H_6 , Benzene;
 $t = 25^\circ\text{C}$ ⁽⁷⁰⁾

% A	(C) (D)	(D) (F)	(F) (G')
0.000	464	1190	1030
16.873	447	1142	985
31.954	428	1090	938
43.419	413	1044	895
55.495	389	991	847
64.704	373	939	804
71.042	358	906	770
79.671	334	845	714
87.689	309	780	660
98.504	289	731	615
100.000	268	668	554

CHCl₃

Chloroform

249. B = C₂H₄O₂, Acetic acid
(137)

% A	(⁶⁵⁶³ ₅₈₉₃)	(⁵⁸⁹³ ₄₉₆₁)	(⁴⁹⁶¹ ₄₃₅₈)	t
27.584	159	552	369	12.9
27.584	201	501	363	22.0
27.584	199	491	369	39.4
50.994	179	581	412	12.1
50.994	210	531	404	22.8
50.994	230	513	390	39.2
68.619	230	569	438	13.0
68.619	220	557	432	24.0
68.619	216	549	430	43.9
80.763	240	583	455	10.0
80.763	240	381*	656*	21.6
80.763	257†	560	434	41.8

* Probably *n*₄₉₆₁ should be 1.42954 instead of 1.42754.† Assumes *n*₆₅₆₃ = 1.40968 instead of 1.42968.250. B = C₂H₆O, Ethyl alcohol
(137)

0.000	172	438	356	10.8
0.000	170	434	347	18.7
0.000	164	420	344	47.5
19.522	181	462	364	8.7
19.522	173	448	361	24.9
19.522	175	449	360	30.2
27.661	186	468	384	10.0
27.661	176	469	368	25.0
27.661	179	456	366	33.0
34.824	205	446	387	6.2
34.824	190	482	382	17.3
34.824	186	474	384	36.6
49.079	194	516	410	11.0
49.079	189	515	405	22.4
49.079	188	499	496	35.8
60.901	212	532	420	10.5
60.901	207	520	409	24.2
60.901	203	510	410	31.3
78.429	231	568	446	7.3
78.429	226	578	441	17.4
78.429	209	579	439	36.5
87.414	225	584	426	11.8
87.414	227	585	454	24.0
87.414	231	568	431	37.5
100.000	255	633	508	10.1
100.000	252	624	515	25.2
100.000	248	613	497	43.5

251. B = C₃H₆O, Acetone
(137); cf. (70, 152)

0.000	198	478	396	9.6
0.000	195	471	392	20.4
0.000	193	465	385	37.4
22.396	208	499	417	10.6
22.396	195	491	410	24.4
22.396	195	466	399	36.0
41.577	215	522	448	11.7
41.577	211	510	423	28.0
41.577	214	501	414	36.2
56.889	223	547	456	10.2
56.889	229	547	476	21.0
56.889	215	511	392	36.5
84.064	238	600	536	12.4
84.064	206	627	453	20.0
84.064	231	580	469	36.3
93.901	253	625	562	12.2
93.901	277	592	562	19.0
93.901	239	510	567	31.2

251.—(Continued)

t = 25°C (70); cf. (71, 152)

% A	(^C _D)	(^D _F)	(^F _{G'})
0.000	186	470	393
16.664	193	487	403
33.039	206	503	414
45.832	210	516	427
56.298	214	532	443
64.507	222	551	455
72.276	226	562	471
79.884	233	578	480
88.409	241	595	497
94.292	250	610	508
100.000	252	623	523

CH₂I₂

Methylene iodide

252. B = C₆H₁₀O₄, Diethyl
oxalate; *t* = 15°C (105)

% A	(^C _F)	(^F _{G'})
0.00	745	435
75.50	1985	1306
100.00	3766	2691

C₂H₄Cl₂

Ethylene chloride

306. B = C₂H₄O₂, Acetic acid
(137)

% A	(⁶⁵⁶³ ₅₈₉₃)	(⁵⁸⁹³ ₄₉₆₁)	(⁴⁹⁶¹ ₄₃₅₈)	t
26.593	210	499	359	9.0
26.593	204	497	355	21.2
26.593	200	474	336	41.8
46.948	218	527	393	9.7
46.948	213	513	393	20.2
46.948	209	496	383	37.2
69.568	223	546	407	8.6
69.568	222	543	412	23.5
69.568	217	527	398	42.0
88.390	233	581	449	9.0
88.390	234	569	436	28.5
88.390	239	553	401	52.3

307. B = C₃H₆C, Acetone (137)

26.844	205	498	383	9.8
26.844	200	490	398	23.8
51.575	213	529	419	7.8
51.575	209	526	415	20.3
72.414	225	558	437	9.8
72.414	225	536	450	25.9
86.874	234	576	453	12.1
86.874	219	585	436	23.3
100.000	250	609	477	9.7
100.000	247	603	467	25.4
100.000	246	578	454	43.0

C₂H₄O₂

Acetic acid

310. B = C₄H₉Br, Butyl
bromide (137)

% B	(⁶⁵⁶³ ₅₈₉₃)	(⁵⁸⁹³ ₄₉₆₁)	(⁴⁹⁶¹ ₄₃₅₈)	t
21.961	192	516	361	14.1
21.961	212	504	367	24.4
21.961	195	503	351	44.4
43.647	219	547	400	13.5
43.647	220	533	397	24.0
43.647	223	527	399	36.1
68.091	237	599	449	13.2

310.—(Continued)

% B	(⁶⁵⁶³ ₅₈₉₃)	(⁵⁸⁹³ ₄₉₆₁)	(⁴⁹⁶¹ ₄₃₅₈)	t
68.091	230	585	437	40.7
100.000	274	693	528	10.4
100.000	276	683	522	26.0
100.000	247	662	504	58.8

312. B = C₆H₆, Benzene*t* = 25°C (70, 71); cf. (152)

% A	(^C _D)	(^D _F)	(^F _{G'})
0.000	465	1191	1030
11.634	436	1105	953
23.614	403	1016	873
34.008	375	943	812
44.857	345	863	736
54.459	318	796	672
63.968	287	732	615
73.819	265	655	548
82.321	244	593	494
91.338	220	529	431
100.000	197	466	376

C₂H₅Br

Ethyl bromide

316. B = C₃H₆O, Acetone (137)

% A	(⁶⁵⁶³ ₅₈₉₃)	(⁵⁸⁹³ ₄₉₆₁)	(⁴⁹⁶¹ ₄₃₅₈)	t
0.000	198	478	396	9.6
0.000	195	471	392	20.4
33.110	191	510	407	16.9
33.110	212	490	426	28.7
50.812	239	532	429	16.3
50.812	224	519	447	28.3
67.809	252	559	473	16.8
67.809	273	538	467	24.7
100.000	291	651	561	16.0
100.000	289	638	564	32.1

C₂H₅I

Ethyl iodide

317. B = C₄H₈O₂, Ethyl ace-
tate; *t* = 25°C (70, 71); cf. (152)

% A	(^C _D)	(^D _F)	(^F _{G'})
0.000	183	450	371
19.082	207	417	510
35.007	231	571	474
49.517	259	643	539
59.741	282	710	594
68.529	310	774	657
74.566	328	827	703
82.792	364	911	779
89.093	393	993	850
94.970	420	1080	925
100.000	458	1166	1002

C₂H₅NO₃

Ethyl nitrate

318. B = C₇H₁₆, Heptane (105)

% B	(^C _F)	(^F _{G'})	t
0.00	811	479	16.2
38.16	745	425	15

319. B = C₁₀H₇Br, α-Bromo-
naphthalene; *t* = 15°C (105)

% B	(^C _D)	(^D _F)	t
59.99	1989	1312	
100.00	3269	2218	

C₂H₆O

Ethyl alcohol

326. B = C₆H₈O₂, Cyclo-
hexan-1, 4-dione (26)

% B	(^C _{G'})	t
0.00	962	16.8
7.55	979	17.5
8.08	988	17.4

328. B = C₉H₆Br₂O₂, Dibro-
mocinnamic acid; *t* = 25°C
(151)

% B	(^C _D)	t
0.000	180	
5.205	191	

329. B = C₉H₇BrO₂, α-Bromo-
cinnamic acid; *t* = 25°C (151)

% B	(^C _D)	t
0.000	180	
4.677	198	
5.041	190	
5.192	200	

330. B = C₉H₇BrO₂, β-Bromo-
cinnamic acid; *t* = 25°C (151)

% B	(^C _D)	t
0.000	180	
4.512	197	
4.877	192	

331. B = C₉H₇BrO₂, α-Bromo-
allocinnamic acid; *t* = 25°C
(151)

% B	(^C _D)	t
0.000	180	
4.824	198	
5.248	200	
5.320	202	

332. B = C₉H₇BrO₂, β-Bromo-
allocinnamic acid; *t* = 25°C
(151)

% B	(^C _D)	t
0.000	180	
5.044	195	

333. B = C₉H₇ClO₂, α-Chloro-
cinnamic acid; *t* = 25°C (151)

% B	(^C _D)	t
0.000	180	
4.984	206	
5.136	206	
5.190	207	
5.469	206	

334. B = C₉H₇ClO₂, α-Chloro-
allocinnamic acid; *t* = 25°C
(151)

% B	(^C _D)	t
0.000	180	
5.008	198	
5.051	197	
5.260	200	

338. B = C₁₂H₁₂O₂, 2-Benzoyl-
cyclopentanone (9)

% B	(^C _D)	(^D _F)	t
0.000	172	407	25.0
4.520	202	496	25.0
6.454	212	532	25.2

C₂H₆O—(Continued)339. B = C₁₃H₁₄O₂, 2-Benzoylcyclohexanone (9)

% B	(C) (D)	(D) (F)	t
0.000	172	407	25.0
2.567	185	428	24.8
2.835	177	428	24.8

C₃H₆O

Acetone

349. B = C₃H₈O, Isopropyl alcohol (98)

$$n_F^{22} = n_C^{22} + 0.00663 \text{ if } 0 < \% B < 100$$

C₅H₅N

Pyridine

372. B = C₁₀H₈, Naphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	426	1231	1022	16.8
9.413	477	1316	1123	16.9
29.426	531	1524	1363	17.0
100.000	746	2110	1933	99.6

C₅H₁₀O₂

Propyl acetate

375. B = C₆H₁₀O₂, Ethyl propionate (92)

$$n_F^{20} = n_D^{20} + 0.01354 \text{ if } 0 < \% B < 100$$

$$n_{G'}^{20} = n_F^{20} + 0.01191 \text{ if } 0 < \% B < 100$$

C₆H₄Br₂*m*-Dibromobenzene377. B = C₉H₇N, Quinoline (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	825	2299	2114	9.6
52.574	727	2030*	1836*	9.4
0.000	815	2294	2102	14.8
29.635	773	2175	1952	14.8

* If $n_F = 1.64599$ instead of 1.65599.**C₆H₅NO₂**

Nitrobenzene

379. B = C₆H₇N, Aniline; $t = 20^\circ\text{C}$ (16)

% B	(C) (D)
0.00	688
16.77	704
29.27	709
46.14	714
62.49	709
77.25	704
100.00	684

380. B = C₁₀H₈, Naphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	682	1869		13.5
8.875	694	1898		14.6
20.327	700	1965		14.6
100.000	746	2110	1833	99.6

381. B = C₁₀H₉N, α -Naphthylamine; $t = 20.8^\circ\text{C}$ (76)

% B	(C) (D)	% B	(C) (D)
0.000	648	8.943	709

C₆H₆

Benzene

383. B = C₇H₇NO₂, *m*-Nitrotoluene (33)

% B	(C) (D)	(D) (F)	(C) (D)	(D) (F)
	$t = 15^\circ\text{C}$		$t = 30^\circ\text{C}$	
0.0	487	1194	483	1187
30.5	543	1371	509	1362
50.4	573	1501	564	1493
72.4	604	1607	592	1605
87.8	637	1698	621	1695
100.0	653	1766	636	1761

384. B = C₇H₉N, *m*-Toluidine (33)

0.0	487	1194	483	1187
25.1	522	1312	523	1289
48.3	560	1409	551	1392
67.1	581	1512	573	1478
84.2	598	1589	594	1547
100.0	620	1657	619	1610

385. B = C₇H₁₆, Heptane; $t = 15^\circ\text{C}$ (105)

% A	(C) (F)	(F) (G')
56.26	1158	718
100.00	1705	1068

386. B = C₈H₁₈O, 1- β -Octanol; $t = 20^\circ\text{C}$ (34)

$$\begin{aligned} (6708) &= 10[55 - 0.30(\% B)]; \\ (5896) &= 10[8 - 0.04(\% B)]; \\ (5790) &= 10[32 - 0.19(\% B)]; \\ (5461) &= 10[178 - 1.25(\% B) + 0.0022(\% B)^2]; \\ (4358) &= 10[85 - 0.53(\% B)]; \\ (4046) &= 10[85 - 0.53(\% B)]; \end{aligned}$$

for density, see Table 1.

390. B = C₁₀H₂₀O₂, 1- β -Octyl acetate; $t = 20^\circ\text{C}$ (34)

$$\begin{aligned} (6708) &= 10[55 - 0.31(\% B)]; \\ (5896) &= 10[8 - 0.04(\% B)]; \\ (5790) &= 10[32 - 0.19(\% B)]; \\ (5461) &= 10[178 - 1.15(\% B) + 0.0010(\% B)^2]; \\ (4358) &= 10[85 - 0.52(\% B)]; \\ (4046) &= 10[85 - 0.52(\% B)]; \end{aligned}$$

for density, see Table 1.

394. B = C₂₇H₄₄, α -Cholesterylene; $t = 20^\circ\text{C}$ (24)

% B	(C) (D)
0.00	478
6.639	461
10.412	459

395. B = C₂₇H₄₆, Cholestene; $t = 20^\circ\text{C}$ (24)

0.000	478
10.104	442
17.979	450

396. B = C₂₇H₄₆O, Cholesterol; $t = 20^\circ\text{C}$ (24)

0.000	478
6.018	466
6.628	471

397. B = C₂₇H₄₈, Cholestane; $t = 20^\circ\text{C}$ (24)

0.000	478
6.151	461

398. B = C₂₉H₄₈OS₂, Methyl cholesteryl xanthogenate; $t = 20^\circ\text{C}$ (24)

0.000	478
6.772	461
11.355	474

399. B = C₂₉H₅₀OS₂, Methyl dihydrocholesteryl xanthogenate; $t = 20^\circ\text{C}$ (24)

0.000	478
10.987	455
15.665	451

C₆H₇N

Aniline

400. B = C₉H₇N, Quinoline (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	651	1830	1637	20.7
83.321	805	2227	2061	20.8
90.291	813	2256	2074	20.9
100.000	816	2279	2100	20.7

401. B = C₁₀H₈, Naphthalene (76)

% B	(C) (D)	(D) (F)	t
0.000	663	1824	16.5
9.998	685	1871	17.2

402. B = C₁₀H₉N, α -Naphthylamine; $t = 21.1^\circ\text{C}$ (76)

% B	(C) (D)	(D) (F)	(F) (G')
0.000	651	1824	1637
10.880	702	1964	1788

C₆H₁₂

Cyclohexane

404. B = C₇H₇NO₂, *m*-Nitrotoluene (33)

% B	(C) (D)	(D) (F)
	$t = 15^\circ\text{C}$	
0.0	225	544
29.8	351	912
50.0	435	1157
70.4	540	1396
86.8	608	1609
100.0	653	1766
	$t = 30^\circ\text{C}$	
0.0	223	550
29.8	351	910
50.0	424	1154
70.4	513	1399
86.8	568	1607
100.0	636	1761

405. B = C₇H₉N, *m*-Toluidine (33)

	$t = 15^\circ\text{C}$	
0.0	225	544
24.1	323	819
45.7	404	1054
61.7	470	1225
82.4	541	1457
100.0	620	1657
	$t = 30^\circ\text{C}$	
0.0	223	550
24.1	303	816
45.7	409	1029
61.7	463	1213
82.4	538	1420
100.0	619	1610

C₆H₁₂O₂

Isobutyl acetate

406. B = C₇H₁₄O₂, Ethyl isovalerate; $t = 20^\circ\text{C}$ (92)

% B	(C) (D)	(D) (F)	(F) (G')
0.0000	566	1349	1193
18.7251	560	1352	1211
31.3151	550	1372	1216
48.3989	562	1358	1206
64.4828	562	1354	1205
77.1855	561	1360	1225
100.0000	565	1352	1225

C₆H₁₂O₂

Ethyl butyrate

407. B = C₆H₁₂O₂, Ethyl isobutyrate; $t = 20^\circ\text{C}$ (92)

% B	(C) (D)	(D) (F)	(F) (G')
0.0000	550	1357	1208
25.4236	543	1358	1216
49.0035	540	1365	1204
74.2817	540	1362	1190
100.0000	537	1348	1212

C ₆ H ₁₄ Hexane		
408. B = C ₇ H ₇ NO ₂ , <i>m</i> -Nitro-toluene (33)		
% B	$\begin{pmatrix} C \\ D \end{pmatrix}$	$\begin{pmatrix} D \\ F \end{pmatrix}$
<i>t</i> = 15°C		
0.0	177	484
28.3	306	858
53.1	421	1166
69.7	507	1377
86.6	613	1602
100.0	653	1766
<i>t</i> = 30°C		
0.0	177	479
28.3	306	849
53.1	433	1148
69.7	499	1380
86.6	578	1594
100.0	636	1761
409. B = C ₇ H ₉ N, <i>m</i> -Toluidine (33)		
<i>t</i> = 22°C		
0.0	177	484
27.7	297	805
44.9	384	995
63.1	453	1208
83.1	554	1447
100.0	620	1639
<i>t</i> = 32°C		
0.0	177	479
27.7	307	787
44.9	362	988
63.1	450	1196
83.1	545	1413
100.0	619	1604

C ₇ H ₆ O Benzaldehyde				
410. B = C ₉ H ₇ N, Quinoline (76)				
% A	(C) (D)	(D) (F)	(F) (G')	<i>t</i>
0.000	820	2293	2088	14.9
17.090	782	2187	1994	14.8

C ₇ H ₆ O ₂ Benzoic acid				
411. B = C ₉ H ₇ N, Quinoline (76)				
% A	(C) (D)	(D) (F)	(F) (G')	<i>t</i>
0.000	813	2284	2096	19.1
40.079	723	1982	1803	19.1
0.000	813	2273	2082	21.6
13.418	776	2193	1971	21.6
45.882	695	1934		21.5
0.000	809	2277	2085	25.0
10.202	787	2205	2001	24.6

C ₇ H ₇ Br Benzyl bromide				
412. B = C ₇ H ₇ Cl, Benzyl chloride; <i>t</i> = 20°C (92)				
% A	(C) (D)	(D) (F)	(F) (G')	
0.0000	502	1207	1017	
18.8772	511	1245	1085	
23.3439	519	1250	1094	
33.0428	512	1274	1087	

412.—(Continued)			
% A	(C) (D)	(D) (F)	(F) (G')
48.0849	513	1301	1117
65.3828	530	1319	1136
73.9944	538	1329	1143
78.9757	532	1348	1150
100.0000	552	1366	1180

C ₇ H ₇ NO ₂ <i>m</i> -Nitrotoluene		
413. B = C ₇ H ₈ , Toluene (33)		
% B	(C) (D)	(D) (F')
<i>t</i> = 15°C		
0.0	653	1766
14.4	617	1686
30.7	604	1572
49.6	540	1472
72.7	519	1315
100.0	469	1145
<i>t</i> = 30°C		
0.0	636	1761
14.4	608	1681
30.7	570	1591
49.6	546	1469
72.7	500	1328
100.0	453	1170

414. B = C ₇ H ₁₄ , Methyl-cyclohexane (33)		
<i>t</i> = 15°C		
0.0	653	1766
15.3	595	1572
32.3	527	1368
51.8	413	1146
73.9	340	867
100.0	230	537
<i>t</i> = 30°C		
0.0	636	1761
15.3	561	1574
32.3	499	1366
51.8	437	1110
73.9	330	855
100.0	223	530

C ₇ H ₈ Toluene		
415. B = C ₇ H ₉ N, <i>m</i> -Toluidine (33)		
% B	(C) (D)	(D) (F)
<i>t</i> = 15°C		
0.0	469	1145
19.0	476	1237
45.9	541	1375
65.4	565	1486
82.4	586	1571
100.0	620	1657
<i>t</i> = 30°C		
0.0	453	1170
19.0	491	1242
45.9	522	1379
65.4	566	1457
82.4	590	1532
100.0	619	1610

416. B = C ₁₂ H ₁₂ O ₂ , 2-Benzoyl-cyclopentanone (9)			
% B	(C) (D)	(D) (F)	<i>t</i>
0.000	441	1134	25.0
5.895	471	1226	25.2
417. B = C ₁₃ H ₁₄ O ₂ , 2-Benzoyl-cyclohexanone; <i>t</i> = 25°C (9)			
% B	(C) (D)	(D) (F)	
0.000	441	1134	
3.607	443	1134	
8.002	444	1146	

C ₇ H ₈ O <i>m</i> -Cresol				
418. B = C ₉ H ₇ N, Quinoline (76)				
% B	(C) (D)	(D) (F)	(F) (G')	<i>t</i>
0.000	495	1325	1143	20.4
88.167	784	2157		19.0
88.584	785	2157		20.4
100.000	812	2282		20.0
100.000	816	2288		20.5
419. B = C ₁₀ H ₈ , Naphthalene (76)				
0.000	490	1344	1137	18.0
9.556	521	1426	1226	18.0
13.000	531	1457	1254	18.0
100.000	746	2110	1933	99.6

C ₇ H ₈ O Anisole				
420. B = C ₉ H ₇ N, Quinoline (76)				
% B	(C) (D)	(D) (F)	(F) (G')	<i>t</i>
80.358	752	2096	1871	8.0
84.809	766	2125	1955	15.0
100.000	827	2299	2109	8.8
100.000	820	2294	2107	15.0
421. B = C ₁₀ H ₈ , Naphthalene (76)				
0.000	468	1285	1153	16.5
11.013	499	1390	1206	16.6
19.089	528	1468	1287	16.8

C ₇ H ₉ N <i>o</i> -Toluidine			
422. B = C ₉ H ₇ N, Quinoline; <i>t</i> = 20.7°C (76)			
% B	(C) (D)	(D) (F)	(F) (G')
0.000	595	1678	1492
90.527	805	2241	2057
100.000	816	2279	2100
423. B = C ₁₀ H ₉ N, α -Naphthylamine; <i>t</i> = 20.7°C (76)			
0.000	595	1678	1492
10.926	648	1824	1671

C ₇ H ₉ N <i>m</i> -Toluidine		
424. B = C ₇ H ₁₄ , Methyl-cyclohexane (33)		
% B	(C) (D)	(D) (F)
<i>t</i> = 15°C		
0.0	620	1657
18.6	541	1450

424.—(Continued)		
% B	(C) (D)	(D) (F)
<i>t</i> = 15°C (Cont'd)		
37.9	462	1247
57.9	398	1004
78.1	319	776
100.0	230	537
<i>t</i> = 30°C		
0.0	619	1610
18.6	542	1417
37.9	480	1203
57.9	385	979
78.1	288	760
100.0	223	539
C ₇ H ₁₆ Heptane		
425. B = C ₁₀ H ₇ Br, α -Bromonaphthalene; <i>t</i> = 15°C (105)		
% B	(C) (F)	(F) (G')
69.46	1959	1282

C ₈ H ₇ N Benzyl cyanide			
426. B = C ₈ H ₁₀ O, Phenetole; <i>t</i> = 15°C (105)			
% B	(C) (F)	(F) (G')	<i>t</i>
0.00	1560	969	15.2
48.73	1597	996	15.0
100.00	1634	1013	14.7

C ₈ H ₈ O Acetophenone				
427. B = C ₉ H ₇ N, Quinoline (76)				
% B	(C) (D)	(D) (F)	(F) (G')	<i>t</i>
77.932	754	2090	1877	14.8
100.000	820	2293	2088	14.9

428. B = C ₁₀ H ₈ , Naphthalene <i>t</i> = 14.9°C (76)			
% B	(C) (D)	(D) (F)	(F) (G')
0.000	524	1455	1255
13.423	557	1553	1387
14.198	569	1568	1375

429. B = C ₁₀ H ₉ N, α -Naphthylamine; <i>t</i> = 20.7°C (76)		
% B	(C) (D)	(D) (F)
0.000	507	1449
0.936	575	1636

C ₈ H ₉ Br Bromo- <i>p</i> -xylene			
430. B = C ₉ H ₇ N, Quinoline; <i>t</i> = 15.2°C (76)			
% B	(C) (D)	(D) (F)	(F) (G')
83.285	772	2142	1984
100.000	819	2294	2107



Ethylbenzene

431. B = C_8H_{10} , *o*-Xylene;
 $t = 20^\circ C$ (92)

% A	(C) (D)	(D) (F)
0.000	445	1131
24.1074	442	1117
50.1866	437	1108
75.2146	434	1096
100.000	447	1085

432. B = C_8H_{10} , *m*-Xylene;
 $t = 20^\circ C$ (92)

% A	(C) (D)	(D) (F)
0.000	468	1122
24.6565	441	1112
50.3372	442	1093
78.8580	428	1100
100.000	447	1085

433. B = C_8H_{10} , *p*-Xylene;
 $t = 20^\circ C$ (92)

% A	(C) (D)	(D) (F)
0.000	465	1097
25.2055	442	1109
51.1066	441	1094
75.2683	434	1096
100.000	447	1085

*o*-Xylene434. B = C_8H_{10} , *m*-Xylene;
 $t = 20^\circ C$ (92)

% B	(C) (D)	(D) (F)
0.000	445	1131
24.6677	442	1130
49.5001	445	1122
74.7756	442	1121
100.0000	468	1122

435. B = C_8H_{10} , *p*-Xylene;
 $t = 20^\circ C$ (92)

% B	(C) (D)	(D) (F)
0.000	445	1131
24.9410	439	1147
49.4932	446	1119
74.7171	443	1101
100.000	465	1097

*m*-Xylene436. B = C_8H_{10} , *p*-Xylene;
 $t = 20^\circ C$ (92)

% B	(C) (D)	(D) (F)
0.000	465	1125
24.9807	468	1104
50.2550	479	1091
75.0229	478	1107
100.000	465	1097



Quinoline

437. B = $C_9H_7N_2O$, 2-Acetyl-
indazole (76)

% B	(C) (D)	(D) (F)	t
0.000	820	2277	20.4
10.013	810	2249	20.0

438. B = $C_9H_{10}O_2$, *o*-Ethyl-
benzoic acid (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	822	2288	2088	19.1
0.000	821	2278	2105	19.8
10.659	781	2183	2007	19.8
11.817	807	2188	1982	19.1
46.712	674	1857	1658	18.9
100.000	453	1321	1122	99.6
100.000	453	1318	1065	100.0

439. B = $C_9H_{10}O_2$, Ethyl
benzoate (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	827	2299	2109	8.8
14.974	763	2129	1941	8.4

440. B = C_9H_{12} , *p*-Methyl-
ethylbenzene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	825	2299	2114	9.6
0.000	824	2290	2107	14.5
18.346	738	2030	1857	14.4
53.375	570	1602	1412	9.6
100.000	382	1121	933	14.6

441. B = $C_{10}H_6Cl_2$,
1, 4-Dichloronaphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	863	2260	2098	15.0
14.297	854	2267	2108	15.0

442. B = $C_{10}H_6Cl_2$,
1, 5-Dichloronaphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	820	2296	2110	15.7
8.541	815	2303	2102	15.8
9.835	828	2290	2111	15.6

443. B = $C_{10}H_6Cl_2$,
1, 7-Dichloronaphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	821	2292	2105	16.1
9.195	819	2294	2116	15.8
28.217	813	2284	2110	16.0
100.000	756	2149	1884	99.5

444. B = $C_{10}H_6Cl_2$,
1, 8-Dichloronaphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	819	2288	2109	17.4
10.086	823	2303	2123	17.4
38.683	834	2328	2168	17.4
100.000	812	2318	1880	99.8

445. B = $C_{10}H_6Cl_2$,
2, 7-Dichloronaphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	820	2292	2105	15.9
9.984	815	2290	2101	15.9
10.510	820	2285	2101	15.9

446. B = $C_{10}H_7Cl$, β -Chloro-
naphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	868	2260	2100	15.3
10.011	877	2255	2140	15.3

448. B = $C_{10}H_7I$, β -Iodo-
naphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	825	2286	2091	17.2
16.824	851	2345	2165	16.8
100.000	952	2647		99.4

449. B = $C_{10}H_8$, Naphthalene
(76)

% B	(C) (D)	(D) (F)	t
0.000	823	2285	16.8
14.438	829	2276	16.8
16.104	837	2270	16.9

450. B = $C_{10}H_8O$, α -Naphthol
(76)

% B	(C) (D)	(D) (F)	t
0.000	825	2278	19.9
10.971	852	2346	19.9
100.000	844	2420	99.3

451. B = $C_{10}H_8O$, β -Naphthol;
 $t = 18.6^\circ C$ (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	816	2289	2102	
9.841	845	2345	2153	
15.571	853	2365	2202	

452. B = $C_{10}H_9N$, α -Naph-
thylamine (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	827	2282	2106	19.6
9.494	858	2417	2275	20.4
9.954	865	2415	2280	19.6
17.358	893	2511	2424	20.4
100.000	1088	3149		51.2
100.000	1083	3156		54.1

453. B = $C_{10}H_9N$, β -Naph-
thylamine (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	823	2271	2092	22.8
9.548	858	2402	2254	22.8
10.682	863	2431		22.9
15.315	891	2468	2352	22.8
16.808	893	2489		22.9

455. B = $C_{10}H_{10}N_2$,
1, 5-Naphthylenediamine (76)

% B	(C) (D)	(D) (F)	t
0.000	828	2289	14.4
8.408	901	2527	13.8
9.646	897	2565	14.4

456. B = $C_{10}H_{10}N_2$,
1, 6-Naphthylenediamine (76)

% B	(C) (D)	(D) (F)	t
0.000	813	2288	19.3
10.189	896	2513	19.3
14.498	922	2605	19.3
100.000	1312	3836	99.4

457. B = $C_{10}H_{10}N_2$,
1, 8-Naphthylenediamine (76)

% B	(C) (D)	(D) (F)	t
0.000	813	2280	19.3
9.125	878	2486	19.2
28.692	997	2904	19.2
100.000	1285		99.4

458. B = $C_{10}H_{10}N_2$,
2, 3-Naphthylenediamine (76)

% B	(C) (D)	(D) (F)	t
0.000	809	2277	25.0
0.000	815	2265	28.4
7.476	863	2424	26.0
8.029	870	2433	27.2

459. B = $C_{10}H_{10}N_2$,
2, 7-Naphthylenediamine (76)

% B	(C) (D)	(D) (F)	t
0.000	824	2298	13.0
0.000	820	2288	17.1
9.581	898	2495	12.5
9.652	895	2488	17.0

460. B = $C_{10}H_{14}$, *p*-Cymene
(76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	823	2302	2113*	13.4
0.000	824	2294	2107	15.2
16.046	737	2058	1865	13.2
18.486	721	2020	1843	15.1
52.013	556	1573	1392	12.9
100.000	387	1036	882	16.1

* If $n_G' = 1.67473$ instead of 1.66473.461. B = $C_{10}H_{14}O$, *p*-Tolyl-
dimethyl carbinol (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	813	2297	2111	13.8
19.223	735	2049	1856	13.7
100.000	384	1138	945	13.5

462. B = $C_{11}H_8O$, α -Naph-
thaldehyde (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	813	2277	2095	21.2
14.012	842	2388	2244	21.3
44.593	926	2603	2560	21.0
100.000	1060	3026	3134	19.3

463. B = $C_{11}H_8O$, β -Naph-
thaldehyde (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	812	2279	2098	21.0
28.679	881	2450	2314	20.7
100.000	994	2879		99.4

464. B = $C_{11}H_{12}O$, 1-Keto-7-
methyl-1, 2, 3, 4-tetrahydro-
naphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	820	2291	2100	16.9
33.830	689	2053	1840	17.0
100.000	506	1486	1319	35.0

465. B = $C_{12}H_8O$, Diphenylene
oxide (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	818	2302	2101	13.5
12.824	835	2326	2146	13.6

466. B = $C_{12}H_{10}$, Diphenyl (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	800	2297	2110	13.4
17.311	810	2255	2074	13.1

467. B = $C_{12}H_{12}O$, β -Naphthyl
ethyl ether (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	847	2260	2105	15.4
10.607	848	2247	2089	15.4

468. B = $C_{12}H_{13}N$, α -Ethyl-
aminonaphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	816	2289	2112	17.4
9.130	853	2390	2265	17.2
48.730	951	2767		16.6
100.000	1015	3026	3263	15.1

469. B = $C_{12}H_{13}N$, β -Ethyl-
aminonaphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	817	2270	2097	24.1
11.512	851	2401	2266	23.6
46.552	934	2717	2730	23.7

470. B = C₁₃H₇Cl₃, Trichloro-
fluorene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	828	2299	2108	11.5
0.000	819	2283	2102	17.6
9.479	822	2299	2116	18.0
9.735	826	2318	2135	11.6
9.906	822	2295	2127	18.5

471. B = C₁₃H₈Br₂,
2, 7-Dibromofluorene (76)

0.000	816	2275	2087	22.9
0.000	809	2263		27.2
9.201	827	2312	2131	24.1
9.532	829	2286		26.8
10.776	827	2316	2124	26.0

472. B = C₁₃H₈O, Fluorenone
(76)

0.000	818	2293	2105	16.7
10.846	845	2361		16.9

473. B = C₁₃H₁₀, Fluorene (76)

0.000	818	2293	2105	16.7
9.171	827	2303	2106	16.8

474. B = C₁₃H₁₂, Diphenyl-
methane (76)

0.000	824	2290	2097	15.7
17.968	770	2144	1954	15.6

475. B = C₁₃H₁₂O, 1-Methyl-
2-acetylnaphthalene (76)

0.000	821	2284	2101	16.5
43.769	843	2390	2281	16.4
100.000	879	2520	2505	16.1

476. B = C₁₃H₁₂O₂, Ethyl
β-naphthoate (76)

0.000	857	2258	2104	15.6
10.530	870	2239	2081	15.6

477. B = C₁₃H₁₄, 1-Methyl-
2-ethylnaphthalene (76)

0.000	821	2291	2108	16.0
64.421	747	2118	1943	15.7
100.000	716	2013	1844	15.4

478. B = C₁₄H₈Br₂,
9, 10-Dibromoanthracene (76)

0.000	765	2128		99.5
0.000	761	2133		99.6
9.114	820	2326		99.7
9.776	833	2334		99.6

479. B = C₁₄H₈Cl₂,
1, 4-Dichloroanthracene (76)

0.000	762	2148		99.0
9.064	822	2303		99.2
9.678	821	2320		99.0

480. B = C₁₄H₈Cl₂,
1, 5-Dichloroanthracene (76)

0.000	756	2150		99.3
0.000	760	2144		99.4
8.278	807	2287		99.3
10.255	825	2323		99.4

481. B = C₁₄H₈Cl₂,
9, 10-Dichloroanthracene (76)

0.000	756	2144		99.3
0.000	765	2136		99.3
9.828	828	2387		99.2
9.972	834	2386		99.3

482. B = C₁₄H₈Cl₂,
9, 10-Dichlorophenanthrene (6)

% B	(6563) (5876)	(5876) (4861)	t
0.000	864	2212	25.4
5.981	879	2250	25.5
6.644	879	2250	25.6

483. B = C₁₄H₉Cl, α-Chloro-
anthracene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	821	2289		17.0
0.000	812	2293	2095	18.9
0.000	756	2137		100.3
11.891	824	2367		99.7
13.780	900	2560	2545	18.8
19.448	938	2685	2752	16.7
100.000	1373	4232		99.5

484. B = C₁₄H₉Cl, β-Chloro-
anthracene (76)

% B	(C) (D)	(D) (F)	t
0.000	766	2138	99.7
9.258	820	2301	99.6
10.346	824	2316	99.7

485. B = C₁₄H₉Cl, 9-Chloro-
anthracene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	819	2297	2106	14.1
0.000	817	2298	2106	14.4
11.713	860	2604	2583	14.4
12.214	904	2578	2597	14.1

486. B = C₁₄H₉Cl, 9-Chloro-
phenanthrene (6)

% B	(6563) (5876)	(5876) (4861)	t
0.000	863	2212	25.6
9.986	886	2281	25.7
10.714	878	2275	25.7
100.000	1093	2892	100.5

487. B = C₁₄H₁₀, Anthracene
(76)

% B	(C) (D)	(D) (F)	t
0.000	760	2146	99.4
9.822	824	2347	99.5
10.950	829	2366	99.5

488. B = C₁₄H₁₀, Phenanthrene
(76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	819	2294	2099	15.6
10.653	856	2380	2171	15.7
25.995	896	2509	2335	15.7
100.000	3942	t _α = 130.6° t _D = 129.6°		

489. B = C₁₄H₁₀Br₂, 2,
7-Dibromo-9-methylfluorene
(76)

0.000	825	2291	2106	13.8
10.013	845	2317	2153	13.7
17.244	840	2355	2173	13.8

490. B = C₁₄H₁₂,
9, 10-Dihydroanthracene (76)

0.000	818	2288	2101	17.3
13.749	788	2200	2017	17.2
18.578	807	2169	1998	17.0

491. B = C₁₄H₁₂, Dihydro-
phenanthrene (6)

% B	(6563) (5876)	(5876) (4861)	t
0.000	917	2212	24.6
9.319	886	2290	24.5
9.911	887	2297	24.5

492. B = C₁₄H₁₂, Stilbene (6)

0.000	870	2226	20.5
9.673	921	2372	19.9
9.709	929	2366	21.7

493. B = C₁₄H₁₄O, 1-Ethyl-4-
acetylnaphthalene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	825	2287	2101	16.0
39.667	826	2324	2210	16.0
100.000	840	2395	2388	15.7

494. B = C₁₄H₁₅NO, α-Acetyl-
ethylaminonaphthalene (76)

0.000	817	2283	2105	20.2
12.087	801	2237	2052	20.3
100.000	660	1874		27.3
100.000	632	1779		99.0

495. B = C₁₄H₁₅NO, β-Acetyl-
ethylaminonaphthalene (76)

0.000	812	2264	2093	24.1
9.873	802	2229	2052	23.5
48.278	751	2105	1874	23.5
100.000	698	1949	1778	23.1

496. B = C₁₄H₁₇N, α-Diethyl-
aminonaphthalene (76)

0.000	825	2289	2101	18.0
10.258	821	2273	2109	18.0
44.072	805	2197	1888	18.0
100.000	720	2079	1895	18.1

497. B = C₁₄H₁₇N, β-Diethyl-
aminonaphthalene (76)

0.000	813	2273	2100	22.1
10.871	848	2372	2266	21.8
46.652	926	2660	2796	21.9
100.000	991	3006	3379	21.6

498. B = C₁₄H₁₇N,
1, 4-Diethylaminonaphthalene
(76)

0.000	818	2298	2106	14.2
23.080	794	2249	2140	14.2
100.000	622	1884	1904	99.6

499. B = C₁₄H₁₇N,
2, 3-Diethylaminonaphthalene
(76)

0.000	814	2281	2097	20.6
10.137	815	2294	2143	20.7
16.494	816	2297	2176	20.8
100.000	736	2192		99.3

500. B = C₁₄H₂₄N₂, Tetra-
ethyl-*o*-phenylenediamine (76)

0.000	822	2305		10.7
19.935	748	2103		10.6
100.000	458	1333	1187	12.6

501. B = C₁₄H₂₄N₂, Tetra-
ethyl-*m*-phenylenediamine (76)

0.000	822	2304		11.2
13.739	791	2236		10.8
46.892	718	2012		11.0
100.000	589	1684	1538	11.8

502. B = C₁₄H₂₄N₂, Tetra-
ethyl-*p*-phenylenediamine (76)

% B	(C) (D)	(D) (F)	t
0.000	822	2305	10.7
14.310	793		10.4
100.000	520	1563	99.3

503. B = C₁₅H₁₀, Fluoranthrene
(6)

% B	(6563) (5876)	(5876) (4861)	t
0.000	869	2222	18.6
9.974	925	2414	18.7
0.000	869	2219	15.3
14.023	955	2503	15.2

504. B = C₁₅H₁₁Cl, 1-Methyl-
4-chloroanthracene (76)

% B	(C) (D)	(D) (F)	(F) (G')	t
0.000	819	2288	2105	17.2
13.007	889	2524	2502	17.2
16.596	917	2582		17.2

505. B = C₁₅H₁₂, α-Methyl-
anthracene (76)

0.000	828	2289	2104	14.5
0.000	820	2290	2103	15.6
9.213	871	2488	2411	15.3
16.901	932	2652	2681	14.4
17.059	936	2652	2661	15.1
100.000	1335	4079		99.4

506. B = C₁₅H₁₂, β-Methyl-
anthracene (76)

0.000	770	2135		99.1
0.000	765			99.5
8.604	831			99.6
9.409	816	2317		99.3

507. B = C₁₅H₁₂, 9-Methyl-
anthracene (76)

0.000	819	2290	2107	14.9
0.000	819	2292	2092	17.0
9.851	890	2538	2525	14.7
10.518	898	2548	2542	16.7
100.000	1423	4486		99.4

508. B = C₁₅H₁₂O, Anthranol
methyl ether (76)

% B	(C) (D)	(D) (F)	t
0.000	819	2288	17.2
10.801	891	2535	17.2
17.879	936	2701	17.2
100.000	1406	4429	99.3

509. B = C₁₅H₁₄, *m*-Methyl-
stilbene (76)

0.000	826	2292	14.5
13.297	884	2479	14.7

510. B = C₁₆H₁₀, Pyrene (6)

% B	(6563) (5876)	(5876) (4861)	t
0.000	878	2221	17.1
13.783	970	2572	17.0
0.000*	869	2222	18.6
9.789*	932	2468	18.8

* A second preparation.

C₉H₇N.—(Continued)511. B = C₁₆H₁₃Cl, 9-Ethyl-10-chloroanthracene (76)

% B	($\frac{C}{D}$) (5593)	($\frac{D}{F}$) (5893) (4861)	($\frac{F}{G'}$) (4861) (4341)	t
0.000	826	2301	2100	13.0
0.000	822	2293		14.2
10.527	896	2559		12.6
11.080	900	2576		14.2

512. B = C₁₆H₁₆O, Ethylhydroanthranol (76)

% B	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	819	2288	2103	16.3
0.000	821	2289		17.0
18.203	771	2129		16.8
24.909	751	2094		16.2

513. B = C₁₇H₁₄Br₂O₂, Ethyl 2,7-dibromofluorene-9-acetate (76)

% B	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	822	2296	2111	13.4
16.726	822	2296	2110	13.3
100.000	773	2181	1948	99.8

514. B = C₁₈H₁₈, Retene (6)

% B	($\frac{C}{D}$) (5876)	($\frac{D}{F}$) (5876) (4861)	t
0.000	870	2223	17.9
10.550	877	2277	17.5
0.000*	864	2211	25.6
11.718*	879	2259	25.6

* A second preparation.

515. B = C₂₀H₂₈O₂, 1, 5-Dihydroxynaphthalene diamyl ether (76)

% B	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	817	2280	2098	22.2
11.097	791	2196	2023	22.3
19.983	762	2140	1958	22.3
100.000	519	1521		99.9

C₁₀H₆Cl₂

1, 4-Dichloronaphthalene

516. B = C₁₀H₁₂, Tetralin (76)

% A	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	433	1255	1045	20.2
12.072	487	1339	1161	20.2

517. B = C₁₀H₁₅N, Diethylaniline (76)

% A	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	588	1614	1494	16.7
12.456	608	1687	1572	16.7

518. B = C₁₂H₁₄O₄, Diethyl phthalate (76)

% A	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	393	1081	921	17.7
13.994	458	1211	1061	17.6

519. B = C₁₂H₁₆O₂, Amyl benzoate (76)

% A	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	384	1032	890	17.4
12.770	420	1158	999	18.3

C₁₀H₈

Naphthalene

520. B = C₁₀H₁₅N, Diethylaniline (76)

% A	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	567	1634	1500	12.3
10.171	600	1698	1559	12.9
20.922	633	1765		13.2
100.000	746	2110	1933	99.6

521. B = C₁₂H₁₄O₄, Diethyl phthalate (76)

% A	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	389	1085	896	16.8
11.274	421	1238	1028	17.5
20.912	488	1340	1167	17.5
100.000	746	2110	1933	99.6

C₁₀H₉N α -Naphthylamine525. B = C₁₀H₁₂, Tetralin (76)

% A	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)	t
0.000	443	1248	1054	20.6
10.572	500	1423	1255	20.7

III. Ternary Aqueous Mixtures

541. B = HNO₃; C = Hg(NO₃)₂, Anhydrous (Pulfrich) (94)

% C	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)
0	19#	42#	35#
5.3037	20#	46#	36#
0	19#	41#	37#
6.6201	22#	37#	46#

542. B = HNO₃; C = Hg₂(NO₃)₂, Anhydrous (Pulfrich) (94)

% C	($\frac{C}{D}$)	($\frac{D}{F}$)	($\frac{F}{G'}$)
0	20#	42#	34#
4.0118	20#	44#	36#
7.4925	20#	46#	36#
0	19#	42#	35#
7.9896	21#	47#	38#

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Ahlman and Enroos, 138, 1: No. 14; 22. (2) Anderson and Story, 1, 45: 1102; 23. Andrews, 1, 30: 353-08. (4) Applebey and Davies, 4, 127: 1836; 25. (5) Aten, 7, 88: 321; 14. (6) von Auwers and Kraul, 13, 443: 181; 25. (7) Bardaudy, 34, 182: 1279; 26. (8) Bardaudy, 27, 39: 371; 26. (9) Bauer, 4, 1: 393; 14.

- (10) Baxter, Boylston, Mueller, Black and Goode, 1, 33: 901; 11. (11) Bell and Cummings, 45, 11: 1028; 19. (12) Bennett and Garratt, 517, 16: 18; 25. (13) Berget, 34, 152: 984; 11. (14) Bernaola, 357, 8: 73; 20. (15) Bichowsky and Merwin, 48, 5: 441; 21. (16) Biron and Morguleva, 53, 46: 1598; 14. (17) Blanc, 357, 4: 294; 16. (18) Briner, Tykociner and Alfimov, 42, 18: 3; 20. (19) Briner and Winkler, 42, 20: 201; 23.
- (20) Buchkremer, Diss., Bonn, 1890. (21) Buchkremer, 7, 6: 161; 90. (22) Carelli, 71, 27: 288; 21. (23) Chugaev and Koch, 34, 153: 259; 11. (24) Chugaev and Koch, 13, 385: 352; 11. (25) Clarke, 4, 99: 1927; 11. (26) Clarke, 4, 101: 1788; 12. (27) Clemens, 45, 13: 813; 21. (28) Cornec, 6, 29: 491; 13. (29) Counson, 149, 5: 361; 23.
- (30) de Crinis, 202, 110: 254; 20. (31) Crombez, 186, 1919: 875. (32) Davies, 1, 44: 2705; 22. (33) Dessart, 28, 35: 9; 26. (34) Dickes, Battersea Polytechnic, London, 0. (35) Dixon and Taylor, 4, 97: 927; 10. (36) Doroszewskii, 53, 43: 46; 11. (37) Doroszewskii, 53, 43: 66; 11. (38) Doroszewskii and Dworzanczyk, 10, 2: 756; 13. (39) Drude, 7, 23: 267; 97.
- (40) Duval, 34, 153: 874; 11. (41) Elsey and Lynn, 50, 27: 342; 23. (42) Forch, 8, 8: 675; 02. (43) Fouquet, 478, 27: 848; 10. (44) Friedländer, 7, 38: 385; 01. (45) Fryer and Fryer, 173, 44: 363; 19. (46) Fürth and Blüh, 55, 34: 129; 24. (47) de García, 357, 8: 381; 20. (48) Getman and Gibbons, 1, 37: 1990; 15. (49) Getman and Gilroy, 11, 48: 138; 12.
- (50) Gladstone and Gladstone, 3, 31: 1; 91. (51, 52) Glazunov, 169, 21: 291; 14. 10, 4: 368; 21. (53) Golse, Thesis, Bordeaux, 1911. 10, 2: 138; 13. (54) Gomberg, 1, 41: 1414; 19. (55) Haas, 141, 35: 119; 18. (56) Iliaigh, 1, 34: 1137; 12. (57) Hammett, 143, 199: 91; 25. (58) Hantzsch, 25, 43: 1651; 10. (59) Hantzsch, 25, 43: 1662; 10.
- (60) Hantzsch, 25, 43: 3049; 10. (61) Hantzsch and Meisenburg, 25, 43: 95; 10. (62) Hess, 75, 114 IIa: 1231; 05. (63) Hess, 8, 27: 589; 08. (64) Heydweiller, 8, 41: 499; 13. (65) Heydweiller and Grube, 8, 49: 653; 16. (66) Holmes, 4, 103: 2147; 13. (67) Holmes, 4, 107: 1471; 15. (68) Horiba, 429, 3: 63; 11. (69) Howard, 141, 41: 537; 20.
- (70) Hubbard, 7, 74: 207; 10. (71) Hubbard, 2, 30: 740; 10. (72) Isaac, 5, 84: 344; 11. (73) Iyer and Usher, 4, 127: 841; 25. (74) Kanonnikov, 52, 31: 321; 85. (75) de Kowalski and de Modzelewski, 34, 133: 33; 01. (76) Krollpfeiffer, 13, 430: 161; 23. (77) Leach and Lythgoe, 1, 27: 964; 05. (78) de Leeuw, 7, 77: 284; 11. (79) Lehfeldt, 3, 40: 397; 95.
- (80) Lehfeldt, 3, 46: 42; 98. (81) Lévi, 24, 75 II: 1916. 10, 4: 354; 21. (82) Lichteneker, 63, 26: 297; 25. (83) Lifschitz and Beck, 55, 26: 10; 20. (84) Lifschitz and Beck, 55, 26: 58; 20. (85) Lifschitz and Brandt, 55, 22: 133; 18. (86) Limann, 96, 8: 13; 22. (87) Merwin, 12, 32: 425; 11. (88) Merwin and Larsen, 12, 34: 42; 12. (89) Meyer and Schoeller, 25, 53: 1410; 20.
- (90) Miers and Isaac, 5, 79: 322; 07. (91) Miller and Worley, 54, 37: 98T; 18. (92) Morguleva, 53, 46: 235; 14. (93) Muchin and Tarle, 181, 43: No. 27; 16. (94) Muller and Carrière, 34, 154: 695; 12. (95) Muller and Guerdjikoff, 34, 155: 774; 12. (96) Nacken, 76, 1918: 192. (97) Öholm, 147, 2: No. 23; 13. (98) Palmer, 173, 45: 302; 20. (99) Parks and Kelley, 50, 28: 727; 24.
- (100) Parks and Schwenck, 50, 28: 720; 24. (101, 102) Pascal, 27, 15: 360; 14. (103) Peacock, 4, 105: 2782; 14. (104) Peacock, 4, 107: 1547; 15. (105) Perkin, 4, 77: 267; 00. (106) Read and Hook, 4, 117: 1214; 20. (107) Reicher and Jansen, 176, 9: 106; 12. (108) Riiber, 25, 55: 3132; 22. (109) Riiber, 25, 56: 2185; 23. 57: 1599; 24.
- (110) Riiber, 25, 57: 1797; 24. (111) Riiber and Esp, 25, 58: 737; 25. (112) Riiber, Sørensen and Thorkelsen, 25, 58: 964; 25. (113) Rimbach and Wintgen, 7, 74: 233; 10. (114) Robertson, 50, 13: 469; 09. (115) Robertson, 141, 7: 359; 10. (116) Robertson, 141, 8: 287; 10. (117) Robertson, 141, 8: 441; 10. (118) Robertson, 141, 8: 507; 10. (119) Robertson, 141, 11: 179; 12.
- (120) Robertson, 141, 11: 307; 12. (121) Robertson, 141, 13: 455; 13. (122) Robertson and Greaves, 141, 9: 181; 11. (123) Rosanoff, Bacon and White, 1, 36: 1803; 14. (124) Rosanoff and Easley, 1, 31: 953; 09. (125) Sanfourche and Boutin, 27, 31: 546; 22. (126) Schmidt, 141, 23: 487; 15. (127) Schoorl, 70, 43: 203; 24. (128) Schütt, 7, 9: 349; 92. (129) Schulze, 1, 36: 498; 14.
- (130) Schulze, 7, 86: 309; 14. (131) Schwes, 27, 7: 875; 10. (132) Schwes, 186, 1911: 641. (133) Schwes, 4, 101: 1889; 12. (134) Schwes, 186, 1912: 55. (135) Schwes, 186, 1912: 252. (136) Schwes, 186, 1912: 525. (137) Schwes, 186, 1912: 610. (138) Schippy and Burrows, 1, 40: 185; 18. (139) Sidersky, 478, 27: 1168; 10.
- (140) Smedley, 4, 95: 218; 09. (141) Smedley, 4, 97: 1475; 10. (142) Smedley, 4, 97: 1484; 10. (143) Söderborg, 8, 41: 381; 13. (144) von Steiger, 25, 55: 1968; 22. (145) Stericker, Diss., Univ. Pittsburgh, 1922. (146) Stone, 1, 45: 29; 23. (147) Svedberg and Andreen-Svedberg, 7, 76: 145; 11. (148) Tournoux, 14, 11: 349; 19. (149) Vasiljev, 53, 43: 1183; 11.
- (150) Vrevskii, 53, 42: 1; 10. (151) Walker and James, 4, 115: 1243; 19. (152) Zawidzki, 7, 35: 129; 00. (153) Zawidzki, 7, 46: 21; 03. (154) Zecchini, 36, 27 I: 358; 97. (155) Zecchini, 36, 35 II: 65; 05.

ELECTRIC AND MAGNETIC BIREFRINGENCE

H. MOUTON

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Introduction.—While a non-crystalline substance is in either an electric or a magnetic field it acts optically as a uniaxial crystal with its axis parallel to the field intensity, Kerr (²³), Cotton and Mouton (^{7, 12}). Some act as positive (+) others as negative (−) crystals. Crystalline substances are excluded from this section. The molecules of "crystalline" liquids seem to be completely aligned by the applied field and the order of the resulting birefringence is 10⁶ times as great as that of the liquids here considered.

General Relations.—If n = index of refraction of the substance when in zero field, n_e and n_o = indices when in a field of strength E (electric) or H (magnetic), λ = wave-length of the light *in vacuo*, l = actual length of path of the light in the substance and perpendicular to the field, δ = difference in the equivalent optical paths of the components with electric vector parallel and perpendicular, respectively, to the field, then the *coefficients of birefringence* (C_e , C_m) are defined by the equations $\delta/\lambda = (n_e - n_o)l/\lambda = C_e E^2$ (or $= C_m H^2$), or $(n_e - n_o) = C_e \lambda E^2$ (or $= C_m \lambda H^2$). C_e and C_m depend upon λ , the temperature (t), and the substance; for any given gas, C_e is proportional to its density (^{19, 27}). C_e is sometimes called Kerr's constant; it should not be confused with Kerr's magneto-optic constant, Vol. VI, p. 435.

Variation with λ .—For any substance at a constant temperature, Havelock (^{20, 21}) concludes that $n(n_e - n_o) = k(n^2 - 1)^2$, or $C_e \lambda n / (n^2 - 1)^2 = k_e$, $C_m \lambda n / (n^2 - 1)^2 = k_m$, where k , k_e , k_m are pure numbers which are independent of λ , cf. (^{30, 31, 37}). For anisole (C₇H₈O), phenetole (C₈H₁₀O), and *m*-xylene (C₈H₁₀), k_e has been found to be independent of λ ; for toluene (C₇H₈) and ethyl *n*-butyrate (C₈H₁₆O₂), k_e varies slightly with λ ; and for ethyl ether (C₄H₁₀O) and acetal (C₆H₁₄O₂), $C_e \lambda$ varies less than this relation indicates (⁴). For a number of substances (^{37, 40}), including nitrobenzene (C₆H₅NO₂) (^{8, 12}), k_m has been found to be independent of λ .

Variation with t .—For a given λ , Langevin (²⁵) concludes that $C_e n T / \{d(n^2 + 2)^2(\epsilon + 2)^2\} = \varphi_e$ and $C_m n T / \{d(n^2 + 2)^2\} = \varphi_m$,

where d = density, ϵ = dielectric constant, and φ_e and φ_m are independent of absolute temperature (T). The constancy of φ_e has been verified for ethyl ether (C₄H₁₀O) and for CS₂ from −78.5°C to +18°C (²⁹), and for nitrobenzene (C₆H₅NO₂) from 6.14°C to 25°C and for 5 values of λ (³⁸). The value of φ_m frequently varies non-linearly by several parts in 1000 per 1°C; cf. Table 5. In Tables 1, 2, 3, coefficients for linear interpolation over short ranges are given if available.

Time Effects.—The time required for C_e to reach its equilibrium value after the field is applied or removed is approximately proportional to C_e and is of the order of 10^{-8} sec = 0.01 μ sec (^{1, 2, 3, 5.1, 17, 36}); see CS₂ (Table 1), and C₇H₈ and C₁₀H₇Br (Table 3). The effect of electrostriction (see Vol. VI, p. 207) and the heating produced by the conduction current complicate the determination of $(n_e - n)$ and $(n_o - n)$ in electric birefringence. Both effects are reduced by applying the field quickly and maintaining it for a very short time (τ); see following.

Ratio of Changes in Index.—Different theories of electric birefringence predict different values for $\rho \equiv (n_e - n)/(n_o - n)$. That which makes the birefringence (electric or magnetic) depend upon the orientation of the molecules makes $\rho = -2$; Voigt's theory (⁴³) which makes it depend upon a modification of the intraatomic forces makes $\rho = +3$, and a more general form of this theory, Enderle (¹⁶), makes ρ vary with λ and approach +3 for frequencies which are small as compared with those characteristic of the electrons. Using very short times (τ) so as to minimize effects of electrostriction (Vol. VI, p. 207) and heating, Pauthemier (³⁵) found for nitrobenzene (C₆H₅NO₂) and $\tau = 0.46, 0.92, 1.6$, and 2.7μ sec (= 10^{-6} sec), $\rho = -2.01, -1.99, -2.03$, and -2.04 , respectively; the same was found for red, yellow-green and blue light; Himstedt (²²) found $\rho = -1.92$; McComb (³¹), $\rho = -1.88$ for $0.540 \mu < \lambda < 0.660 \mu$. For CS₂, electrostriction compensates the change in $(n_o - n)$, making the apparent (ρ') value of ρ infinite, when $\tau = 8.1 \mu$ sec. If electrostriction alone increases the index

from n to $n + \delta'$, and we write $\beta \equiv \delta'(n_o - n)$, then $\rho' = (\beta + 2)/(\beta - 1)$; for CS_2 , Pauthenier (35) found as follows:

τ	0.65	1.3	2.5	4.9	7	8.1	9.8
β	0	0	0.12	0.36	0.74	1	1.4
τ	20	25	30.7	41.7	49	65.6	$\mu \text{ sec}$
β	2	1.47	1	1.3	1.1	1.1	

Relation between Electric and Magnetic Birefringence.—The preceding temperature relations indicate that $C_e/\{C_m(\epsilon + 2)^2\} = \varphi_e/\varphi_m$ is independent of T . Cotton and Mouton (12) have proposed the simpler relation $C_e/(C_m\epsilon) = \text{const.}$, and have found it more satisfactory for nitrobenzene ($\text{C}_6\text{H}_5\text{NO}_2$); their values are as follows, a and b being arbitrary constants:

t	aC_e	bC_m	ϵ	$\frac{a}{b} \cdot \frac{C_e(10)^4}{\epsilon C_m}$	$\left(\frac{C}{C_{16^\circ}}\right)_e$	$\left(\frac{C}{C_{16^\circ}}\right)_m$
6°C	68	129	39.4	133.9	1.18	1.08
16	57.6	119.5	37.4	129.0	1.00	1.00
33	45.8	105.2	34.2	127.4	0.796	0.881
54	37.2	90.8	30.6	133.9	0.646	0.760

Units.—Unit of $\lambda = 1\mu = 10^4 \text{ \AA} = 10^{-4} \text{ cm}$.

TABLE 1.—ELECTRIC BIREFRINGENCE OF CS_2 (6, 18, 29, 30)

$n_e - n_o = C_e\lambda E^2$. $A \times 10^{-7} = C_e$ when λ is expressed in cm and E in egs electrostatic units. Time required for A_{20} to attain equilibrium value is $0.014\mu \text{ sec} = 14 \times 10^{-9} \text{ sec}$ (17). $A_{15} = 1.025 A_{20}$, $A_{28} = 0.966 A_{20}$; approximately $A_t = A_{20} [1 - 0.005(t - 20)]$ if $18^\circ < t < 28^\circ\text{C}$ (26, 27); for lower temperatures, see below. For effect of electrostriction, see above.

λ	A	$A\lambda$	t'	A_t/A_{18°
	$(t = 20^\circ\text{C})$			(29)
0.589	$+3.226^* \pm 0.005$		$+18^\circ\text{C}$	1.000
0.440	$+4.97$	2.187	0	1.089
0.460	$+4.63$	2.130	-18.5	1.205
0.480	$+4.32$	2.073	-37.7	1.397
0.500	$+4.06$	2.030	-47.3	1.497
0.520	$+3.83$	1.991	-68.3	1.708
0.540	$+3.63$	1.960	-78.5	1.819
0.546	$+3.577^\dagger$	1.953		
0.560	$+3.45$	1.932		
0.578	$+3.310^\dagger$	1.913		
0.580	$+3.30$	1.914		
0.589	$+3.226^\dagger$	1.900		
0.600	$+3.15$	1.890		
0.630	$+2.95$	1.858		
0.660	$+2.78$	1.835		

* Basis of reference (6).

† (6).

TABLE 2.—MAGNETIC BIREFRINGENCE OF NITROBENZENE ($\text{C}_6\text{H}_5\text{NO}_2$) (9, 12)

$(n_e - n)/(n_o - n) = -2.00$, $k_m \equiv C_m\lambda n/(n^2 - 1)^2 = 1.11 \times 10^{-16}$ at 19 to 20°C , is independent of λ . $\varphi_m = C_m n T / \{d(n^2 + 2)^2\}$ varies non-linearly with T ; $C_e/C_m\epsilon$ is nearly independent of t . $C_{mt} = C_{m_{20}} [1 - \alpha(t - 20)]$; if $10^\circ\text{C} < t < 25^\circ\text{C}$, $\alpha = 1/35$; near 20°C , $\alpha = 1/44$; mean variation per 1°C between 6.4°C and 53.9°C is $1/38$ of mean value of C_m (8, 12). $n_e - n_o = C_m\lambda H^2$; $A \times 10^{-12} = C_m$, if λ is expressed in cm and H in egsm (gauss). $t = 20^\circ\text{C}$; $1\mu = 10^{-4} \text{ cm}$.

λ	0.578	0.436	0.486	0.546	0.578	0.656
A	$2.46 \pm 0.02^*$	3.62	3.10	2.66	2.46	2.14
$A\lambda$		1.580	1.509	1.450	1.422	1.405

* Basis of reference; derived from $A = 2.53 \pm 0.02$ at 16.3°C (9).

TABLE 3.—ELECTRIC AND MAGNETIC BIREFRINGENCE OF PURE SUBSTANCES: RELATIVE VALUES

For most inorganic liquids C_e and C_m are inappreciable, but magnetic birefringence should be exhibited by those paramagnetic substances which have quite anisotropic molecules (cf. aqueous solution of erbium nitrate, Table 4). For organic substances containing only C, H and O, C_m is very small or zero if they are acyclic, and, so far as they have been studied, it is inappreciable if they contain a cyclic nucleus without a double bond.

In this table $\gamma_e/100 \equiv (C/C_{\text{CS}_2})_e$, where C and C_{CS_2} refer to the same temperature (20°C) and the same radiation (usually D-line, $\lambda = 0.589\mu$), and $\gamma_m/100 \equiv (C/C_{\text{C}_6\text{H}_5\text{NO}_2})_m$ where $\text{C}_6\text{H}_5\text{NO}_2$ = nitrobenzene, C and $C_{\text{C}_6\text{H}_5\text{NO}_2}$ refer to the same temperature (t_m) and to the yellow mercury line ($\lambda = 0.578\mu$). For most substances γ_e is nearly independent of λ ; as a first approximation, γ_m is independent of t_m . Available data for variation of C_e and γ_e with t and λ are given in footnotes; for variation of C_m and γ_m , see Table 5. For $C_e(\text{CS}_2)$ and $C_m(\text{C}_6\text{H}_5\text{NO}_2)$, see Tables 1 and 2.

Data for γ_e are from (26) unless another source is indicated in a footnote: those for γ_m are from (9, 12). g = gas at 20°C and 1 atm., l = liquid, b = boils at, m = melts at.

Pure inorganic substances

Formula		γ_e	γ_m	$t, ^\circ\text{C}$	Lit.
H_2O	l	123		17	(35)
SO_2	g	0.051		17.3	(38, 41)
HNO_3	l		$+2.5$	15.5	(9, 12)
NH_3	g	0.0185		20	(26, 27)
	g	0.0181		17.9	(38, 41)
CO_2	g	0.007		20	(26, 27)
	g	0.0074		17.5	(38, 41)

Glasses (Schott and Gen.) (42), $t = 20^\circ\text{C}$

Number	γ_e	% PbO	% SiO_2	Number	γ_e	% PbO	% SiO_2
O378	0.288	27.5	59.3	O41	2.950	61.0	34.7
O569	1.096	36.3	54.1	O165	3.277	65.5	31.2
O118	1.845	43.8	46.6	O198	3.951	71.0	27.2

Carbon compounds (C-arrangement)

Formula	Substance	γ_e	γ_m	t_m
CCl_4	Carbon tetrachloride.....	$+$ 2.3	0	14.6
CCl_3NO_2	Chloropicrin.....	$-$ 55.7	$+$ 3.4	14.2
CN_4O_8	Tetranitromethane.....	$+$ 3	$+$ 1.0	14.2
CS_2	Carbon disulfide.....	$+$ 100.00*	$-$ 19.6	15.5
CHBr_3	Bromoform.....	$-$ 86	$-$ 6.8	14.6
CHCl_3	Chloroform.....	$-$ 100	$-$ 2.8	17.2
CHN	Hydrocyanic acid (g).....	$+$ 0.55		
CH_2Cl_2	Methylene chloride.....	$-$ 36		
CH_2I_2	Methylene iodide.....		$-$ 12.3	16
CH_3Br	Methyl bromide (g).....	$+$ 0.216		
CH_3Cl	Methyl chloride (g).....	$+$ 0.163		
CH_3I	Methyl iodide.....	$+$ 208†	$-$ 2.9	14
CH_3NO_2	Nitromethane.....	$+$ 330	$+$ 3.6	18.4
C_2Cl_4	Tetrachloroethylene.....	$+$ 24		
C_2HCl_3	Trichloroethylene.....	$+$ 43		
C_2HCl_5	Pentachloroethane.....	$-$ 20		
$\text{C}_2\text{H}_2\text{Br}_4$	1, 1, 2, 2-Tetrabromoethane...	$-$ 103		
$\text{C}_2\text{H}_2\text{Cl}_2$	1, 2-Acetylene dichloride.....	$+$ 40		
$\text{C}_2\text{H}_2\text{Cl}_4$	1, 1, 2, 2-Tetrachloroethane...	$-$ 88.7	$-$ 1.3	16
$\text{C}_2\text{H}_2\text{Cl}_3$	1, 1, 2-Trichloroethane.....	$+$ 50		
$\text{C}_2\text{H}_4\text{Br}_2$	Ethylene bromide.....	$+$ 89	$-$ 7.1	16.4
$\text{C}_2\text{H}_4\text{Cl}_2$	Ethylene chloride.....	$+$ 181	$-$ 2.1	14
$\text{C}_2\text{H}_4\text{Cl}_2$	1, 1-Dichloroethane.....	$-$ 1.8		14
$\text{C}_2\text{H}_4\text{O}_2$	Acetic acid (17°).....	$+$ 130†		
$\text{C}_2\text{H}_5\text{Cl}$	Ethyl chloride (g).....	$+$ 0.270		
$\text{C}_2\text{H}_5\text{I}$	Ethyl iodide.....	$+$ 343		
$\text{C}_2\text{H}_5\text{O}$	Ethyl alcohol.....	$+$ 23.8†	$+$ 0	14.6
$\text{C}_3\text{H}_5\text{Cl}$	3-Chloropropylene.....	$+$ 174		
$\text{C}_3\text{H}_5\text{ClO}$	Epichlorohydrin.....	$+$ 185		
$\text{C}_3\text{H}_5\text{ClO}_2$	Ethyl chloroformate.....	$+$ 354		
$\text{C}_3\text{H}_5\text{NS}$	Ethyl isothiocyanate.....		$-$ 8.4	14.6
$\text{C}_3\text{H}_6\text{O}$	Acetone.....	$+$ 505	$+$ 1.6	20.2

TABLE 3.—(Continued)

Formula	Substance	γ_e	γ_m	t_m
C ₃ H ₆ O ₂	Propionic acid.....	+ 44		
C ₃ H ₆ O ₂	Ethyl formate.....	+ 138		
C ₃ H ₇ Br	<i>n</i> -Propyl bromide.....	+ 318		
C ₃ H ₇ Cl	<i>n</i> -Propyl chloride.....	+ 234		
C ₃ H ₈ O	<i>n</i> -Propyl alcohol.....	- 78		
C ₃ H ₈ O ₂	Methylal.....	+ 0.3		
C ₄ H ₄ S	Thiophene.....		+ 15.6	14.8
C ₄ H ₅ Br ₃ O ₂	Ethyl tribromoacetate.....		- 2.2	16
C ₄ H ₅ Cl ₃ O ₂	Ethyl trichloroacetate.....	+ 161		
C ₄ H ₅ N	Pyrrole.....	+ 12§	+ 7 ca.	16
C ₄ H ₆ O	Methyl ethyl ketone.....	+ 420		
C ₄ H ₈ O ₂	Isobutyric acid.....	+ 6		
C ₄ H ₈ O ₂	Ethyl acetate.....	+ 52		
C ₄ H ₉ Br	Isobutyl bromide.....	+ 271.5		
C ₄ H ₁₀ O	<i>n</i> -Butyl alcohol.....	- 113		
C ₄ H ₁₀ O	Isobutyl alcohol.....	- 137		
C ₄ H ₁₀ O	<i>tert</i> -Butyl alcohol.....	+ 154		
C ₄ H ₁₀ O	Ethyl ether.....	- 20.5		
C ₄ H ₁₀ S	Ethyl sulfide.....	+ 10.6		
C ₄ H ₁₀ S ₂	Ethyl disulfide.....	- 168		
C ₄ H ₁₁ N	Diethylamine.....	- 15.3		
C ₅ H ₄ O ₂	Furfural.....		+ 45 ca.	17
C ₅ H ₅ N	Pyridine.....	+ 632	+ 27 ca.	18.5
C ₅ H ₆	Cyclopentadiene.....	+ 14.1	(b. 40 to 43°C)	
C ₅ H ₇ NO ₂	Ethyl cyanoacetate.....	+ 1 200	+ 0	14.6
C ₅ H ₈	Isoprene.....		2.7	16.3
C ₅ H ₈ O ₂	Acetylacetone.....		+ 4.2	16.3
C ₅ H ₁₀	Amylene.....	+ 8	(b. 36 to 37°C)	
C ₅ H ₁₀ O ₂	<i>n</i> -Valeric acid.....	+ 8.4		
C ₅ H ₁₀ O ₂	Methyl <i>n</i> -butyrate.....	+ 24		
C ₅ H ₁₀ O ₃	Diethyl carbonate.....	+ 9.6		
C ₅ H ₁₁ Cl	Isoamyl chloride.....	+ 108		
C ₅ H ₁₁ Cl	<i>tert</i> -Amyl chloride.....	+ 345		
C ₅ H ₁₂	<i>n</i> -Pentane.....	+ 2.0		
C ₅ H ₁₂	2-Methylbutane.....	+ 1.6		
C ₅ H ₁₂ O	<i>n</i> -Amyl alcohol¶.....	- 98		
C ₅ H ₁₂ O	<i>tert</i> -Amyl alcohol.....	+ 40		
C ₅ H ₁₂ N	Isoamylamine.....	- 0.3		
C ₆ H ₃ ClN ₂ O ₄	2, 4-Dinitrochlorobenzene.....	(Fused)	108	(?)
C ₆ H ₃ N ₃ O ₇	2, 4, 6-Trinitrophenol.....	+ 45		
C ₆ H ₄ Cl ₂	<i>o</i> -Dichlorobenzene.....	+ 1 320§		
C ₆ H ₄ Cl ₂	<i>m</i> -Dichlorobenzene.....	+ 218§		
C ₆ H ₅ Br	Bromobenzene.....	+ 374	+ 25.7	15.7
C ₆ H ₅ Cl	Chlorobenzene.....	+ 385	+ 28.8	20
C ₆ H ₅ ClO	<i>o</i> -Chlorophenol.....	+ 189		
C ₆ H ₅ ClO ₂ S	Benzenesulfone chloride.....	+ 2 775		
C ₆ H ₅ F	Fluorobenzene.....	+ 191**	+ 25.5	13
C ₆ H ₅ I	Iodobenzene.....	+ 288	+ 24.8	16.4
C ₆ H ₅ NO ₂	Nitrobenzene (21.3°).....	+ 10 070††	+ 100.0††	13.4
C ₆ H ₆	Benzene.....	+ 12	+ 23.3	18.3
C ₆ H ₇ N	Aniline.....	- 50.7§	+ 16.0	13.4
C ₆ H ₈ N ₂	Phenylhydrazine‡.....	+ 0	+ 29.6	20.4
C ₆ H ₁₀ O ₃	Ethyl acetoacetate.....	+ 145		
C ₆ H ₁₁ NO ₂	Ethyl β -aminocrotonate.....	+ 960		
C ₆ H ₁₂	Cyclohexane.....	+ 2.2	+ 0	
C ₆ H ₁₂ O	Cyclohexanol.....	- 286		
C ₆ H ₁₂ O ₂	Caproic acid.....	+ 8.7		
C ₆ H ₁₂ O ₂	Ethyl <i>n</i> -butyrate.....	+ 21§§		
C ₆ H ₁₂ O ₃	Paraldehyde.....	- 713	+ 0	
C ₆ H ₁₄	<i>n</i> -Hexane.....	+ 1.7		
C ₆ H ₁₄ O ₂	Acetal.....	- 19		
C ₇ H ₄ F ₃ NO ₂	<i>p</i> -Nitrophenylfluoroform.....		+ 58.0	15
C ₇ H ₅ ClO	Benzoyl chloride.....	+ 66	+ 23.8	13.6
C ₇ H ₅ Cl ₃	Phenylchloroform.....	+ 25.4		17
C ₇ H ₅ F ₃	Phenylfluoroform.....	+ 26.7		16.8
C ₇ H ₅ N	Benzonitrile.....	+ 39.5		14
	Benzonitrile ($\lambda = 0.550\mu$).....	+ 36.2		20.2
C ₇ H ₅ Cl ₂	Benzylidene chloride.....	+ 318	+ 23.8	16.6
C ₇ H ₆ O	Benzaldehyde.....	+ 2 496	+ 59.5	15.2
C ₇ H ₇ Cl	<i>o</i> -Chlorotoluene.....	+ 270¶¶		
C ₇ H ₇ Cl	<i>p</i> -Chlorotoluene.....	+ 711¶¶		
C ₇ H ₇ Cl	Benzyl chloride.....		+ 24.2	16.6
C ₇ H ₇ NO	Benzaldoxime‡.....		+ 67.6	12.5
C ₇ H ₇ NO ₂	<i>o</i> -Nitrotoluene.....	+ 5 400	+ 58 ca.	16.5
C ₇ H ₇ NO ₂	<i>m</i> -Nitrotoluene.....	+ 5 500	+ 77 ca.	22
C ₇ H ₇ NO ₂	<i>p</i> -Nitrotoluene‡.....	+ 6 900		
C ₇ H ₈	Toluene.....	+ 24***	+ 24.5	17.5
C ₇ H ₈ O	Benzyl alcohol.....	- 477	+ 26.0	15.8

TABLE 3.—(Continued)

Formula	Substance	γ_e	γ_m	t_m
C ₇ H ₈ O	<i>m</i> -Cresol.....	+ 657		
C ₇ H ₈ O	Phenyl methyl ether†††.....	+ 35.5	+ 22.2	16.5
C ₇ H ₉ N	<i>o</i> -Toluidine.....	- 73		
C ₇ H ₉ N	<i>m</i> -Toluidine.....	- 128		
C ₇ H ₁₂ O ₄	Diethyl malonate.....	+ 48		
C ₇ H ₁₄	Methylcyclohexane.....	+ 2		
C ₇ H ₁₄ O	Heptaldehyde.....	+ 125		
C ₇ H ₁₄ O	Dipropyl ketone.....	+ 157		
C ₇ H ₁₄ O	1-Methylcyclohexanol.....	- 172		
	2-Methylcyclohexanol.....	- 163		
	3-Methylcyclohexanol.....	- 319		
C ₇ H ₁₄ O ₂	Heptylic acid.....	+ 8.2		
C ₇ H ₁₄ O ₂	<i>n</i> -Amyl acetate.....	+ 38		
C ₇ H ₁₄ O ₂	Ethyl <i>n</i> -valerate.....	+ 10		
C ₇ H ₁₆	<i>n</i> -Heptane.....	+ 3.3		
C ₇ H ₁₆ O	<i>n</i> -Heptyl alcohol.....	- 233		
C ₈ H ₆	Phenylacetylene.....		+ 27.5	14.1
C ₈ H ₇ ClO	<i>m</i> -Chloroacetophenone.....	+ 2 140		
C ₈ H ₇ N	Benzyl cyanide.....		+ 22.5	14.2
C ₈ H ₈	Styrene (redistilled).....		+ 36.8	15.2
C ₈ H ₈ O	Acetophenone‡.....	+ 2 069	+ 49	21.7
C ₈ H ₈ O ₂	Methyl benzoate.....		+ 40.3	14.8
C ₈ H ₉ ClO	<i>p</i> -Chlorophenetole.....		+ 26.4	15.1
C ₈ H ₉ FO	<i>p</i> -Fluorophenetole.....		+ 30.8	17.8
C ₈ H ₉ N	Benzylidenemethylamine.....		+ 45.8	13.6
C ₈ H ₁₀	<i>o</i> -Xylene.....	+ 41	+ 27.8	11
C ₈ H ₁₀	<i>m</i> -Xylene‡.....	+ 24	+ 25.0	16.2
C ₈ H ₁₀	<i>p</i> -Xylene.....	+ 23	+ 26.6	20
C ₈ H ₁₀	Ethylbenzene.....	+ 25.6	+ 21.5	17.4
C ₈ H ₁₀ O	Phenylethyl alcohol.....		+ 19.0	13.8
C ₈ H ₁₀ O	Phenetole‡.....	+ 41	+ 21.8	14.8
C ₈ H ₁₁ N	Dimethylaniline.....	+ 312		
C ₈ H ₁₄ O ₃	Ethyl dimethylacetoacetate.....	+ 137.5		
C ₈ H ₁₆	<i>n</i> -Octylene.....	+ 13	(b. 116 to 126°C)	
C ₈ H ₁₆	1, 3-Dimethylcyclohexane.....	+ 3		
C ₈ H ₁₆ O ₂	<i>n</i> -Caprylic acid.....	+ 9.4		
C ₈ H ₁₈	<i>n</i> -Octane.....	+ 4.2	(b. 110 to 125°C)	
C ₈ H ₁₈ O	<i>n</i> -Octyl alcohol.....	- 236		
C ₉ H ₇ N	Quinoline.....	+ 466§	+ 83.0	14.9
C ₉ H ₈	Indene.....		+ 44.6	13.8
C ₉ H ₁₀	Hydrindene.....		+ 28.4	15.2
C ₉ H ₁₀ O	Hydratropaldehyde.....	+ 314		
C ₉ H ₁₀ O ₂	Benzyl acetate.....		+ 33 ca.	(?)
C ₉ H ₁₀ O ₂	Ethyl benzoate.....		+ 37	16
C ₉ H ₁₀ O ₃	Ethyl salicylate.....	+ 607		
C ₉ H ₁₁ N	<i>Py</i> -Tetrahydroquinoline.....		+ 36.5	16.8
C ₉ H ₁₂	Cumene.....	+ 102§§§	+ 26.0	14.5
C ₉ H ₁₂	Mesitylene.....	+ 19	+ 22.2	16
C ₉ H ₁₂	<i>n</i> -Propylbenzene.....		+ 20.3	18.3
C ₉ H ₁₂	Pseudoecumene.....	+ 30	+ 28.0	15.6
C ₉ H ₁₈ O ₂	Pelargonic acid.....	+ 8.3		
C ₁₀ H ₇ Br	α -Bromonaphthalene 	+ 332	+ 99	17
C ₁₀ H ₇ Cl	α -Chloronaphthalene.....		+ 108	15
C ₁₀ H ₉ N	α -Methylquinoline.....	+ 25.6	+ 93.6	16.5
C ₁₀ H ₁₀	Phenylbutadiene.....		+ 64	15.4
C ₁₀ H ₁₀ O ₂	Safrol.....		+ 24.1	17.2
C ₁₀ H ₁₀ O ₂	Isosafrol.....		+ 49.5	17.2
C ₁₀ H ₁₂ O	Anethole.....		+ 74.1	21.4
C ₁₀ H ₁₂ O ₂	Eugenol.....		+ 20.9	15.8
C ₁₀ H ₁₂ O ₂	Isoeugenol.....		+ 36.0	16.8
C ₁₀ H ₁₂ O ₂	<i>n</i> -Propyl benzoate.....		+ 33	13.4
C ₁₀ H ₁₄ O	Carvacrol.....	+ 83	+ 15.1	13
C ₁₀ H ₁₄ O	Carvone.....	+ 730¶¶¶		
C ₁₀ H ₁₄ O	Thymol‡.....		+ 17.7	13.4
C ₁₀ H ₁₆ N	Diethylaniline.....	+ 323		
C ₁₀ H ₁₆	Limonene.....	+ 18¶¶¶	($d_{15} = 0.845$ g cm ⁻³)	
C ₁₀ H ₁₆ O	Camphor.....	+ 159¶¶¶		
C ₁₀ H ₁₈	Dihydropinene.....		+ 0	
C ₁₀ H ₁₈	Dihydrolimonene.....		+ 0	
C ₁₀ H ₁₈ O	Cineol.....		+ 0	
C ₁₀ H ₂₂	Diisooamyl.....	+ 2.2		
C ₁₀ H ₂₃ N	Diamylamine.....	- 6.05		
C ₁₁ H ₇ N	α -Naphthyl cyanide‡.....		+ 166	17
C ₁₁ H ₁₀	α -Methylnaphthalene.....	+ 66		
C ₁₁ H ₁₂ O ₂	Ethyl einnamate.....	+ 228	+ 60 ca.	17
C ₁₁ H ₁₂ O ₃	Ethyl benzoylacetate.....	+ 495		
C ₁₁ H ₂₄ O ₂	Methyl diamyl ether.....	+ 0		

TABLE 5.—MAGNETIC BIREFRINGENCE: VARIATION WITH TEMPERATURE AND WAVE-LENGTH

α_m = mean temperature coefficient of C_{mt} between t' and t'' ; $\Delta/100 \equiv (\varphi_{mt} - \varphi_{m20})/\varphi_{m20}$ where $\varphi_{mt} \equiv C_{mt}nT/\{d(n^2 + 2)^2\}$, T = absolute temperature corresponding to t . $k_m \equiv C_m\lambda n/(n^2 - 1)^2$; $C_m \equiv (n_o - n_e)/(\lambda H^2)$. If λ is expressed in cm, $C_m = A \times 10^{-12}$, $k_m = B \times 10^{-17}$. $\gamma_m/100 = (C/C_{C_6H_5NO_2})_m$, t and λ same for each C . C_{550} , γ_{550} , etc. = value for $\lambda = 0.550\mu$, etc.

Variation with Temperature (39)

Formula	Substance	α_m	t' , °C	t'' , °C	$\Delta t'$	$\Delta t''$
C_6H_5Br	Bromobenzene.....	$\frac{1}{444}$	4.7	54.7	5.2	-6.6
C_6H_5Cl	Chlorobenzene.....	$\frac{1}{139}$	5.2	55.1	5.7	-7.4
$C_6H_5NO_2$	Nitrobenzene.....	$\frac{1}{135}$	5.4	56.3	6.7	-7.9
	Nitrobenzene (9, 12).....	$\frac{1}{135}^*$	10	25		
	Nitrobenzene (12).....	$\frac{1}{144}$	20	20		
	Nitrobenzene (12).....	$\frac{1}{138}$	6.4	53.9		
C_9H_{12}	Pseudocumene.....	$\frac{1}{143}$	5.1	54.5	4.0	-4.8
$C_{10}H_7Br$	α -Bromonaphthalene.....	$\frac{1}{118}$	5.7	52.4	0.4	-0.8
	α -Bromonaphthalene (12).....	$\frac{1}{303}$	11.8	47.9		
$C_{13}H_{10}O_3$	Salol (12) (m. 41.5°C)....	$\frac{1}{486}^\dagger$	-17	50.5		

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Abraham and Lemoine, *34*, 129: 206; 99. *6*, 20: 264; 00. (2) Aeckerlein, *63*, 7: 594; 06. (3) Aeckerlein, *63*, 8: 117; 07. (4) Becker, *8*, 76: 849; 25. (5) Bergholm, *8*, 53: 169; 17. (5.1) Cabannes, *Ann. Faculté Sci. Marseille*, 18: 225; 09. (6) Chaumont, *16*, 4: 61; 15. *5*: 17; 15. (7) Cotton and Mouton, *34*, 145: 229; 07. (8) Cotton and Mouton, *34*, 147: 193; 08. 149: 340; 09. (9) Cotton and Mouton, *34*, 150: 776; 10. 151: 862; 10. (10) Cotton and Mouton, *34*, 154: 818, 930; 12. (11) Cotton and Mouton, *34*, 156: 1456; 13. (12) Cotton and Mouton, *6*, 19: 154; 10. 20: 194; 10. (13) Cotton and Mouton, *6*, 28: 209; 13. (14) Elias, *88*, 12: 955; 10. (15) Elias, *63*, 13: 136; 12. (16) Enderle, *Diss.*, Freiburg, 1912. (17) Gutton, *34*, 156: 387, 1370; 13. *51*, 3: 206, 445; 13. (18) Hagenow, *2*, 27: 196; 08. (19) Hansen, *Diss.*, Berlin, 1912.

Variation with Wave-length (40), $H = 10.11$ kilogauss

Formula	Substance	t , °C	B	A_{550}	A_{589}	γ_{550}	γ_{589}
C_6H_5Br	Bromobenzene.....	20.2	3.29	8.01	7.27	30.5	30.6
C_6H_5Cl	Chlorobenzene.....	19.8	4.14	8.79	8.14	33.4	33.6
$C_6H_5NO_2$	Nitrobenzene.....					100.0	100.0
C_7H_5N	Benzonitrile.....	20.2	4.37	9.60	8.66	36.2	36.3
C_7H_5ClO	Benzoyl chloride....	19.9	2.27	19.5	15.9	66.0	66.3
C_7H_8	Toluene.....	19.4	3.85	7.23	6.71	27.7	28.0
C_7H_5O	Benzyl alcohol.....	20.2	2.79	6.31	5.91	24.0	24.3
C_8H_{10}	<i>m</i> -Xylene.....	20.2	3.61	6.99	6.33	26.2	26.4
C_8H_{10}	<i>p</i> -Xylene.....	19.7	3.73	7.03	6.53	26.8	27.2
C_9H_7N	Quinoline.....	19.7	6.85	21.1	19.5	81.1	81.2
$C_{10}H_{12}O$	Anethole.....	19.1	7.81	19.2	17.4	72.7	72.5

* Of C_{m200} .† Of C_{m200} ; variation is sensibly linear, $C_{mt} = C_{m200}\{1 - \frac{1}{480}(t - 20)\}$.

- (20) Havelock, *5*, 80: 28; 07. (21) Havelock, *2*, 28: 136; 09. (22) Hinstedt, *8*, 59: 322; 19. (23) Kerr, *3*, 50: 337, 446; 75. *8*: 85, 229; 79. *9*: 157; 80, 13: 153, 348; 82. (24) Kerr, *3*, 37: 380; 94. (25) Langevin, *199*, 7: 249; 10. (26) Leiser, *Elektrische Doppelbrechung der Kohlenstoffverbindungen*. Halle, Knapp, 1910. (27) Leiser, *63*, 12: 955; 11. *26*, 13: 903; 11. (28) Lippmann, *9*, 17: 15; 11. (29) Lyon and Wolfram, *8*, 63: 739; 20. (30) McComb, *2*, 29: 525; 09. (31) McComb, *2*, 6: 180; 15. (32) de Malle-mann, *34*, 177: 1028; 23. (33) de Malle-mann, *34*, 180: 1483; 25. (34) de Malle-mann, *51*, 7: 295; 26. (35) Pauthenier, *51*, 2: 183, 384; 21. (36) Pockels, *199*, 9: 148; 12. (37) Skinner, *2*, 29: 541; 09. (38) Szivessy, *96*, 2: 30; 20. (39) Szivessy, *8*, 68: 127; 22. (40) Szivessy, *96*, 18: 97; 23. (41) Szivessy, *96*, 26: 323; 24. (42) Tauern, *8*, 32: 1064; 10. (43) Voigt, *Lehrbuch der Optik*, p. 352; 1900. *63*, 7: 811; 06.

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CHEMICAL KINETICS¹

ANTON SKRABAL

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FORMAL TREATMENT

Mathematical treatment of homogeneous, heterogeneous, isothermal and adiabatic reactions.

Bibliography

(For a key to the periodicals see end of volume)

- (¹) Abel, *9*, 12: 681; 06. 19: 933; 13. 7, 56: 558; 06. (²) Arrhenius, *147*, 1: No. 9; 08. (³) Baur, *7*, 93: 240; 19. 112: 199; 24. (⁴) Baur and Orthner, *7*, 91: 75; 16. (⁵) Benedicks, *7*, 70: 12; 10. (⁶) Bodenstein and Wolgast, *7*, 61: 422; 08. (⁷) Boselli, *34*, 152: 256, 374, 602; 10. (⁸) Bray, *50*, 9: 573; 05. (⁹) Bredig and Epstein, *93*, 42: 341; 04. (¹⁰) Brunner, *7*, 51: 494; 05. 58: 1; 07. (¹¹) Einstein, *76*, 1920: 380. (¹²) Fuhrmann, *7*, 89: 520; 89. (¹³) Goldschmidt, *9*, 11: 5; 05. (¹⁴) von Grützner, *278*, 141: 63; 11. (¹⁵) Guldberg and Waage, *Untersuchungen über die chemische Affinität*, in Ostwald, *Klassiker der exakten*

- Naturwissenschaften*, No. 104; 99. (¹⁶) Harcourt and Eason, *62*, 156: 193; 66. (¹⁷) Hartridge and Roughton, *5*, 104: 376; 23. (¹⁸) Hinshelwood and Bowen, *3*, 40: 569; 20. 5, 99: 203; 21. 7, 101: 504; 22. (¹⁹) Hirniak, *Beiträge zur chemische Kinetik*. Lemberg, 1911. 7, 75: 675; 11. (²⁰) van't Hoff, *Études de dynamique chimique*. Amsterdam, 1884. (²¹) Jüttner, *9*, 15: 169; 09. 7, 65: 595; 09. 77: 735; 11. (²²) Jungius, *7*, 49: 368; 04. (²⁴) Kaufler, *7*, 55: 502; 06. (²⁵) Lewis, *System of physical chemistry*. London, Longmans, 1921. (²⁶) Lotka, *50*, 14: 271; 10. 7, 72: 508; 10. 80: 159; 12. (²⁷) Lowry and John, *4*, 97: 2634; 10. (²⁸) De Lury, *50*, 10: 423; 06. (²⁹) Luther, *9*, 12: 596; 06. (³⁰) Mellor, *Higher mathematics for students of chemistry and physics*. New York, Longmans, 1922. *Chemical statics and dynamics*. New York, Longmans, 1904. (³¹) Mieli, *36*, 37 II: 155, 636; 07. (³²) Miller, *69*, 2 III: 245; 08. 50, 11: 9; 07. (³³) Miller and Rosebrugh, *69*, 9 III: 73; 03. (³⁴) Mittasch, *7*, 50: 613; 05. (³⁵) Moesveld, *7*, 103: 481; 23. (³⁶) Muller, *34*, 169: 793; 19. (³⁷) Nernst, in *Boltzmann Festschrift*, p. 904. Leipzig, Barth, 1904. 93, 45: 126; 05. 49: 213; 06. 7, 47: 52; 04. (³⁸) Nernst and Hohmann, *7*, 11: 352; 93. (³⁹) Noyes, *7*, 19: 599; 96.

- (40) Noyes and Scott, 7, 18: 118; 95. (41) Ostwald, *Lehrbuch der allg. Chemie*, II: 199. Leipzig, Engelmann, 1902. (42) Piazza, 7, 93: 183; 19. (43) Quartaroli, 36, 33 I: 497; 03. (44) Rakovskii, 7, 57: 321; 07. (45) Reichstein, 9, 15: 734; 09. (46) Reiner, 93, 127: 187; 23. 141: 363; 25. (47) Robertson and Acree, 11, 49: 474; 13. (48) Rosebrugh and Miller, 50, 14: 816; 10. (49) Scheffer, 70, 40: 477; 21.
- (50) Shröder and Acree, 4, 105: 2582; 14. (51) Skrabal, 57, 37: 137; 16. (52) von Smoluchowski, 7, 92: 129; 17. (53) Snethlage, 7, 90: 1; 15. (54) Thiersch, 7, 111: 175; 24. (55) Visser, 7, 52: 257; 05. (56) Wagner, 7, 115: 130; 25. (57) Walker, 68, 22: 22; 97. (58) Wegscheider, 7, 30: 593; 99. 35: 513; 00. 36: 543; 01. 39: 257; 02. 41: 62; 02. 57, 21: 693; 00. 29: 83, 233; 08. 36: 471; 15. 39: 15, 201; 18. 9, 14: 133; 08. 28: 99; 22. (59) Winther, 7, 100: 566; 22.
- (60) Zawidski, 165, 1915A: 275. 1916A: 339. (61) Zawidski and Staronka, 165, 1915A: 319. (62) Zawidski and Zaykowski, 165, 1916A: 752.

THEORIES OF REACTION RATE

Reaction rate as a function of temperature and nature of the medium. Applications of statistical mechanics, theories of radiation (quantum theory) and activation theories.

Bibliography

(For a key to the periodicals see end of volume)

- (1) Arrhenius, 7, 4: 226; 89. 28: 317; 99. (2) Auerbach, 9, 11: 296, 433; 05. *Ergebnisse der exakt. Naturwiss.*, 1: 228; 22. (3) Baly, 70, 41: 516; 22. 83, 17: 588, 598; 22. (4) Baly and Rice, 4, 101: 1475; 12. (5) Baumé, 34, 157: 774; 13. (6) Berthelot, 34, 160: 440, 519; 15. (7) Berthoud, 42, 9: 352; 11. 10: 573; 12. (8) Bjerrum, 93, 109: 275; 20. 7, 108: 82; 24. (9) Bodenstein, 9, 24: 183, 381; 18. 7, 49: 61; 04. 100: 68; 22.
- (10) Böeseken, 64V, 31: 226; 22. (11) Boltzmann, 8, 22: 39; 84. *Vorlesungen über Gastheorie*, II: 177. Leipzig, Barth, 1896. (12) Briner, 34, 157: 281, 664; 13. (13) Brönsted, 7, 102: 169; 22. 103: 307; 23. 1, 42: 761, 1448; 20. 45: 2898; 23. 4, 119: 574; 21. 214, 2: No. 10; 19. 3: No. 9; 20. 147, 5: No. 25; 19. (14) Brönsted and LaMer, 1, 46: 555; 24. (15) Brönsted and Petersen, 1, 43: 2265; 21. (16) Cassel, 96, 2: 90; 20. 3: 31; 20. (17) Christiansen, 7, 103: 91; 23. 113: 35; 24. (18) Christiansen and Kramers, 7, 104: 451; 23. (19) Cohen, 7, 23: 442; 97.
- (20) Corran and Lewis, 1, 44: 1673; 22. (21) Dhar, 93, 141: 1; 25. (22) Dushman, 143, 189: 515; 20. 1, 43: 397; 21. (23) Ebert, 9, 30: 65; 24. (24) Einstein, 8, 37: 832; 12. 63, 18: 121; 17. (25) von Euler and Rudberg, 96, 16: 54; 23. (26) Fricke and Rohmann, 9, 30: 580; 24. (27) Goldschmidt, *Diss.*, Breslau, 1907. 63, 10: 206, 421; 09. (28) Griffith, Lambie and Lewis, 4, 111: 389; 17. (29) Haber, 88, 13: 1117; 11.
- (30) Haber and Just, 9, 16: 275; 10. 8, 36: 308; 11. (31) Harned and Brumbaugh, 1, 44: 2729; 22. (32) Harned and Seftz, 1, 44: 1475; 22. (33) Herzfeld, 8, 59: 635; 19. 9, 25: 301; 19. 7, 95: 139; 20. 98: 161; 21. 63, 22: 186; 21. 96, 8: 132; 21. (34) Hückel, *Ergebnisse der exakten Naturwiss.*, 3: 199; 24. (35) Jäger, 75, 100 IIa: 1182; 91. 104 IIa: 671; 95. (36) Jeans, *The Dynamical theory of gases*. Cambridge Univ. Press, 1921. (37) Jellinek, *Physikalische Chemie der homogenen und heterogenen Gasreaktionen*. Leipzig, S. Hirzel, 1913. (38) Job, 27, 33: 1561; 23. (39) Kohnstamm and Scheffer, 64V, 19: 878; 11.
- (40) Krüger, 188, 1908: 318. (41) Lambie and Lewis, 4, 105: 2330; 14. 107: 233; 15. (42) Langmuir, 1, 42: 2190; 20. (43) Lazarev, 34, 178: 773; 24. (44) Lewis, 65, 43: 257; 07. 7, 61: 129; 08. 4, 109: 796; 16. 111: 457; 1086; 17. 113: 471; 18. 115: 182, 710, 1360; 19. *Scientia*, 25: 450; 19. 3, 39: 26; 20. 83, 17: 573; 22. (45) Lewis and McKeown, 1, 43: 1288; 21. (46) Lindemann, 3, 40: 671; 20. 83, 17: 599; 22. (47) Lowry, 83, 17: 596; 22. (48) Lueck, 1, 44: 757; 22. (49) Marcelin, 34, 151: 1052; 10. 157: 1419; 13. 158: 116, 407; 14. 6, 3: 120; 15.
- (50) March, 63, 18: 53; 17. (51) Moran and Lewis, 4, 121: 1613; 22. (52) Natanson, 8, 38: 288; 89. (53) Padoa, 36, 51 I: 193; 21. (54) Perrin, 6, 11: 5; 19. 83, 17: 546; 22. (55) Polanyi, 9, 26: 49, 228; 20. 96, 1: 337; 20. 2: 90; 20. 3: 31; 20. (56) Randall and Vanselow, 1, 46: 2418; 24. (57) Rice, 1, 45: 2808; 23. 183, 1915: 397. (58) Rice, Fryling and Wesolowski, 1, 46: 2405; 24. (59) Rodebush, 1, 45: 606; 23.
- (60) Rosanoff, 1, 35: 173; 13. (61) Sackur, 9, 15: 865; 09. 8, 36: 958; 11. (62) Scheffer, 64V, 20: 761; 11. 21: 1134; 13. 64P, 17: 695, 1011; 13. (62.5) Sirkin, *Ber. polytech. institut. Ivanova-Wosnessensk.*, 7: 143; 23. 63, 24: 236; 23. 7, 106: 243; 23. (63) Skrabal, 57, 35: 1157; 14. 37: 495; 16. 9, 28: 224; 22. (64) Skrabal and Rieder, 9, 30: 109; 24. (65) von Smoluchowski, in *Boltzmann Festschrift*, p. 626. Leipzig, Barth, 1904. 8, 25: 205; 08. (65.5) Stern, 8, 44: 497; 13. (66) Taylor and Lewis, 4, 121: 665; 22. (67) van Thiel, 64V, 31: 232; 22. 64P, 25: 199; 22. (68) Thomson, 3, 47: 337; 24. (69) Tolman, 1, 42: 2506; 20. 43: 126, 269; 21.
- (70) Trautz, 7, 66: 496; 09. 67: 93; 09. 68: 295, 637; 10. 74: 747; 10. 76: 129; 11. 9, 15: 692; 09. 18: 513, 908; 12. 21: 118; 15. 22: 104; 16. 25: 4, 297; 19. 93, 88: 285; 14. 93: 177; 15. 95: 74; 16. 96: 1; 16. 97: 113,

127, 241; 17. 102: 81, 149; 17. 104: 169; 18. 106: 95, 149; 19. 171, 1915: No. 2. 8: No. 3; 17. In *Elster und Geitel Festschrift*, 1915: 333. 96, 2: 117; 20. (71) Trautz and Volkman, 7, 64: 53; 20. (72) Wagner, 7, 115: 121; 25. (73) Wegscheider, 7, 103: 273; 23.

GENERAL INTRODUCTION

Isothermal Monomolecular First-Order Reactions: $A \longrightarrow$

$$\frac{dx}{dt} = k(a - x) \text{ or } -\frac{dC}{dt} = kC \quad (I)$$

Integration gives:

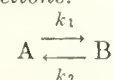
$$k = \frac{1}{t} \log_e \frac{a}{a - x} \text{ or } k = \frac{1}{t} \log_e \frac{C_0}{C} \quad (II)$$

and

$$k = \frac{1}{t_2 - t_1} \log_e \frac{a - x_1}{a - x_2} \text{ or } k = \frac{1}{t_2 - t_1} \log_e \frac{C_1}{C_2} \quad (III)$$

If \log_{10} is used instead of \log_e , the constant will become $k' = 0.4343k$; a or C_0 = the initial concentration of the reacting substance and $(a - x_n)$, or C_n , its concentration at a time t_n units later.

Reversible First-Order Reactions.



$$\frac{dx}{dt} = k_1(a - x) - k_2(b + x) \quad (IV)$$

$$k_1 + k_2 = \frac{1}{t} \log_e \frac{x_\infty}{x_\infty - x} \text{ or } = \frac{1}{t_2 - t_1} \log_e \frac{x_\infty - x_1}{x_\infty - x_2} \quad (V)$$

where

$$x_\infty = x \text{ for } t = \infty, \approx x \text{ at equilibrium,}$$

where

$$\frac{b + x_\infty}{a - x_\infty} = \frac{k_1}{k_2} = K_E, \text{ the "equilibrium constant"} \quad (VI)$$

If π be any property of the reacting mixture such that

$$\pi = p(a - x) + q(b + x), \quad (VII)$$

where p and q are proportionality factors, then

$$k_1 + k_2 = \frac{1}{t} \log_e \frac{\pi_0 - \pi_\infty}{\pi - \pi_\infty} \text{ or } = \frac{1}{t_2 - t_1} \log_e \frac{\pi_1 - \pi_\infty}{\pi_2 - \pi_\infty}, \quad (VIII)$$

where the subscript identifies the time to which the π value belongs.

If A and B are optical antipodes,

$$k_1 = k_2 = k, k_1 + k_2 = 2k, \text{ and } K_E = 1 \quad (IX)$$

Isothermal Bimolecular Second-Order Reactions: $A + B \longrightarrow$

$$\frac{dx}{dt} = k(a - x)(b - x) \quad (X)$$

$$k = \frac{1}{t(b - a)} \left(\log_e \frac{a}{a - x} - \log_e \frac{b}{b - x} \right)$$

or

$$k = \frac{1}{(t_2 - t_1)(b - a)} \left(\log_e \frac{a - x_1}{a - x_2} - \log_e \frac{b - x_1}{b - x_2} \right) \quad (XI)$$

or if $b = a$

$$k = \frac{1}{ta} \frac{x}{a - x} \text{ or } = \frac{1}{t_2 - t_1} \left(\frac{1}{a - x_2} - \frac{1}{a - x_1} \right) \quad (XII)$$

If a differs but slightly from b , a series expansion of Eq. (XI) may be used; or k may be taken as the geometrical mean of the values obtained from Eq. (XII) by putting, 1st, $a = a$ and 2nd, $a = b$.

The differential equation is given in case the rate does not follow a simple law, and the integrated expression is then often omitted.

Progressive Change in k .— \downarrow (resp. \uparrow) = "the value of k is greatest at the beginning (resp. end) of the reaction."

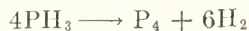
Temperature Coefficient.—The effect of temperature will be exhibited approximately by $Q_{10} = \frac{k_{\theta+10}}{k_\theta}$ where k_θ is the value of k at θ° ; or more exactly by the constant A in the equation $\log_e k = A/T + J$ or $\log_{10} k' = -A'/T + J'$ where A' (resp. J') = $0.4343 \times A$ (resp. $\times J$). E (= RA , where R is the gas constant) has been called the "internal energy" (Rice), the "critical energy" (Marcelin), the "critical energy increment" (McC. Lewis) or the "activation heat" (Arrhenius).

EXPERIMENTAL DATA

First-Order Gas Reactions

Nearly all reactions of this class take place almost entirely on the surface of the containing vessel as shown by the increase of k with increasing ratio of surface to volume; and several investigators have expressed the opinion that *true* first-order reactions do not exist (417). However, as a result of recent work, several examples are known; cf. $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$ and $\text{N}_2\text{O}_5 \rightarrow \text{N}_2\text{O}_4 + 1/2\text{O}_2$ below. For nearly all these first-order gas reactions k has been shown to decrease at very low pressure (254.5, 411.5); and new theories have been advanced (419.5). The important qualitative result is that the new evidence favors the collision mechanism and not the radiation theory.

DECOMPOSITION OF PHOSPHINE



Manometric method; t in seconds (309).

$T, ^\circ\text{K} \dots\dots\dots$	845	785	719	640	583
$10^3k \dots\dots\dots$	540	2.1	0.81	0.19	0.053

The observed values have been smoothed by graphing. The calculated values are computed from the equation:

$$\log_{10} k = \frac{-18\,963}{T} + 2 \log_{10} T + 12.130; \text{ cf. (160)}$$

% G = % of reaction in the gas phase; $100 - \% \text{ G} = \% \text{ on walls}$; t in seconds (517).

$T, ^\circ\text{K}$	10^3k		% G	$T, ^\circ\text{K}$	10^3k		% G
	obs.	calc.			obs.	calc.	
956	18.3	18.0	100	940	8.3	8.0	96
953	15.0	15.5	100	936	7.1	6.5	92
948	12.0	12.0	100	933	6.3	5.6	89
945	10.2	10.3	100	929	5.5	4.5	82
942	9.1	8.9	98	928	4.6	3.3	72
				918	3.8	2.5	66

Measurements in quartz vessels with and without addition of quartz powder; t in seconds; S/V = surface/volume; even at 1044°K the reaction is obviously not a homogeneous one (258).

$S/V = 1 \text{ cm}^{-1};$ $E = 49\,500$	$T, ^\circ\text{K} \dots$	1044	1018	998	970	946		
	$10^3k \dots$	74	26.7	19.5	10.9	5.29		
$S/V = 8.6 \text{ cm}^{-1};$ $E = 41\,800$	$T, ^\circ\text{K} \dots$	1007	979	956	917	894	858	828
	$10^3k \dots$	110	49	32	13.2	5.92	2.41	1.19
$S/V = 15.7 \text{ cm}^{-1};$ $E = 34\,100$	$T, ^\circ\text{K} \dots$	983	963	919	890	864		
	$10^3k \dots$	110	70.7	30.8	19.2	8.89		

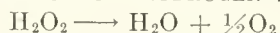
REARRANGEMENT OF TRIMETHYLENE TO PROPYLENE



Bodenstein and Wolgast's gas-stream method with analysis of condensate by density; t in seconds; $E = 54\,800$ to $70\,400$; $Q_{10} = 1.55$; the reaction is influenced by the walls, whose effect can, however, be largely diminished (519).

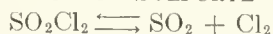
$^\circ\text{C} \dots\dots\dots$	550	570	580	600	600	650
$10^3k \dots\dots\dots$	6.87	15.2	22.2	44.7	45.7	146

DECOMPOSITION OF HYDROGEN PEROXIDE



Manometric method; t in minutes; $k = 0.22$ to 0.38 at 76.0°C ; wall reaction (257).

DECOMPOSITION OF SULFURYL CHLORIDE



Manometric method; t in minutes; wall reaction (257); at temperatures above 200°C in the dark, the equilibrium concentration of SO_2Cl_2 is negligibly small (514.5).

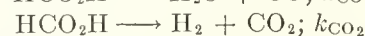
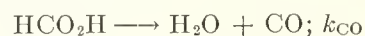
$^\circ\text{C}$	$\frac{\log_e 2}{k}$	Q_{10}	E
211	172		
237	26.5	2.06	35 000
283	1.6	1.85	34 000

DECOMPOSITION OF SULFURYL CHLORIDE.—(Continued)

Manometric method; t in minutes; at 320°C rate is uninfluenced by a 200-fold increase of the ratio of surface to volume. Concluded to be a *true* first-order reaction at and above this temperature (491.5).

$T, ^\circ\text{K} \dots\dots\dots$	552.3	572.5	593.1	602.4
$10^5k \dots\dots\dots$	6.09	27.1	132.1	274.2
$E \dots\dots\dots$		46 400	51 850	55 700

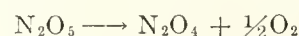
DECOMPOSITION OF FORMIC ACID



Manometric method; wall reaction dependent on nature of glass used; t in minutes; % P = % of $(\text{CO}_2 + \text{H}_2)$ formed (256); for catalysis by Al_2O_3 , *v.* (16, 17).

$^\circ\text{C} \dots\dots\dots$	137.5	158	236	236	239	302	302	350
$10^4k'_{\text{CO}} \dots\dots\dots$	0.49	3.6	12.1	11.4	14.4	46.5	58.0	159
% P $\dots\dots\dots$	1.5	1.6	2.5	9.0	3.4	10.8	14.4	29.1
$^\circ\text{C} \dots\dots\dots$	237	302	302	350	$E = 12\,000 \text{ (CO)}$			
$10^4k'_{\text{CO}_2} \dots\dots\dots$	0.66	5.6	9.8	65	$E = 24\,500 \text{ (CO}_2)$			

DECOMPOSITION OF NITROGEN PENTOXIDE



Manometric method with correction for NO_2 formation; t in minutes;

$$E = 24\,700; \log_e k = \frac{-12\,443}{T} + 35.56 \text{ (132)}$$

$^\circ\text{C}$	65	55	45	35	25
$10^3k \dots \left\{ \begin{array}{l} \text{obs.} \\ \text{calc.} \end{array} \right.$	290*	90.0	29.9	8.08	2.03
	286	93.2	28.3	7.90	(2.03)
$^\circ\text{C}$	25	20	15	0	
$10^3k \dots \left\{ \begin{array}{l} \text{obs.} \\ \text{calc.} \end{array} \right.$	1.91†	1.17†	0.624†	0.0472†	
	2.03	0.992	0.475	0.0440	

* Average using Bodenstein's calculations (51).

† Vapor saturated with solid N_2O_5 ; values less accurate.

Effect of NO_2 at the beginning of the reaction

According to later measurements by Daniels *et al.* (133, 134, 560), traces of NO_2 are necessary for a smooth monomolecular course of the reaction, which would thus have an autocatalytic induction period. However, White and Tolman (549.5) have found no evidence of this effect at the lowest concentration measurable, and conclude that the reaction is monomolecular in its initial stage.

Colorimetric method; t in minutes; the values of k agree with those above.

$^\circ\text{C} \dots\dots\dots$	20	25	35	40
Initial $p_{\text{N}_2\text{O}_5}$, mm. $\dots\dots\dots$	1.3–55	2.5–29	2.9	2.5
$10^3k \dots\dots\dots$	1.03	2.19	8.37	14.8

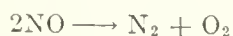
Decomposition in solvents; gas-volumetric method; t in seconds (346).

$^\circ\text{C}$	CCl_4			CHCl_3			Gas*
	10^4k	Q_{10}	E	10^4k	Q_{10}	E	
55	21.2						15.0
50	11.6	3.47	25 292	12.8			
45	6.11	3.60	26 070				5.0
40	3.22	3.77	25 242	3.81	3.33	24 252	
35	1.62	3.83	26 218				1.35
30	0.8415	3.96	24 222	1.025	3.73	24 648	
25	0.409		25 770				0.34
	Mean: 25 469			Mean: 24 450			

* (132, 133).

Higher-Order Gas Reactions

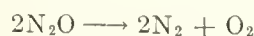
DECOMPOSITION OF NITRIC OXIDE



Analysis with nitrometer; units: seconds and M/cm³; second-order k (278, 515); cf. (379).

$T, ^\circ\text{K}$	k	Q_{10}	A	$T, ^\circ\text{K}$	k	Q_{10}	A
1 620	191 800			1 201	624.6	1.11	15 970
1 525	47 059	1.16	36 440	1 108	228.3	1.12	14 400
1 355	3 843	1.16	30 390	962	39.82	1.13	12 740
1 252	1 073.6	1.13	21 000				

DECOMPOSITION OF NITROUS OXIDE



Gas-density method; units: seconds and M/cm³; second-order k (276).

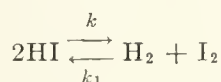
$T, ^\circ\text{K}$	k	A
986	6.72	32 800
1 078	110.9	30 800
1 168	977.0	31 900
Mean: 31 800		

Manometric method; units: seconds and M/l (255).

$T, ^\circ\text{K}$	Values of k , second-order				
1125	12.5	10.6			
1085	3.70	3.27	3.93	4.05	(4.47)
1053	1.38	1.59	1.82	1.91	
1030	0.84	0.85	0.77	0.98	1.14
1001	0.38	0.51			
967	0.135				
838	0.011				

The reaction is homogeneous since neither quartz powder nor Pt or Rh foil influences its rate.

DECOMPOSITION AND FORMATION OF HYDROIODIC ACID



$$\frac{d[\text{I}_2]}{dt} = k[\text{HI}]^2 - k_1[\text{H}_2][\text{I}_2] \quad (\text{I})$$

$$\frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} = \frac{k}{k_1} = K_E \quad (\text{II})$$

Titrimetric method; k_1 (obs.)—4th column—by the gas-current method; k_1 (calc.) from Equation II above, and the relation $\log_e K_E = -90.48/T - 1.5959 \log_e T + 0.0055454T + 2.6981$; units: minutes and M/22.4l (49).

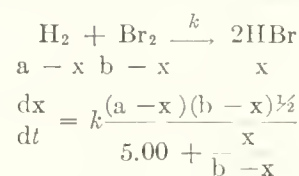
$T, ^\circ\text{K}$	k (obs.)	k_1 (obs.)	k_1 (calc.)	k_1 (calc.)
556	0.06942	0.03119		0.0796
575	0.0326	0.0353		0.0239
599		0.00146		
629	0.04809	0.00676		0.00546
647	0.0230	0.0140		0.0146
666	0.03588	0.0379		0.0350
679		0.0568	0.0535	
683	0.00137	0.0659		0.0784
700	0.00310	0.172		0.164
703		0.250	0.225	
713		0.362	0.336	
716	0.00670	0.375		0.337
781	0.1059	3.58		4.21

$$\log_e k = \frac{-21\,922.5}{T} - 14.468 \log_e T + 0.02305T + 104.185.$$

$$\log_e k_1 = \frac{-21\,832}{T} - 12.872 \log_e T + 0.0055454T + 2.6981.$$

For discussion of theory of the reaction, *v.* (160, 336).

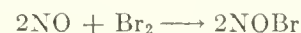
FORMATION OF HYDROBROMIC ACID



Titrimetric method; units: minutes and M/22.4l (52); cf. (380, 411).

$^\circ\text{C}$	k	Q_{10}	$^\circ\text{C}$	k	Q_{10}
301.3	0.0856		251.4	0.00260	2.00
277.5	0.0159	2.03	224.7	0.00036	2.25

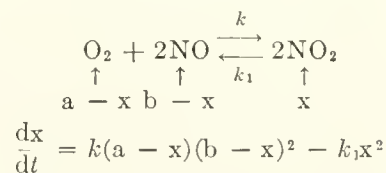
FORMATION OF NITROSYL BROMIDE



Manometric method; units: seconds and M/cm³; third-order k ; homogeneous reaction plus some wall reaction (518, 518.5).

$T, ^\circ\text{K} \dots \dots$	258	265	273	279	286
$10^{-10}k \dots \dots$	1.4(?)	1.2	1.2	1.9	0.9(?)

FORMATION AND DECOMPOSITION OF NITROGEN DIOXIDE



Manometric method; units: minutes and M/l; smoothed values (50); formation of NO₂.

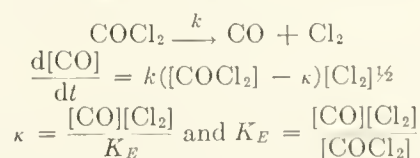
$T, ^\circ\text{K} \dots \dots \dots$	273	308	333	363	414
$10^{-6}k \dots \dots \dots$	2.09	1.59	1.31	1.12	0.925
$Q_{10} \dots \dots \dots$		0.912	0.932	0.949	0.963
$T, ^\circ\text{K} \dots \dots \dots$	470	514	561	613	662
$10^{-6}k \dots \dots \dots$	0.791	0.724	0.681	0.659	0.649
$Q_{10} \dots \dots \dots$	0.972	0.980	0.988	0.993	0.997

k and k_1 calculated from K_E .

$T, ^\circ\text{K}$	NO ₂ -decomposition			NO ₂ -formation	
	k_1	k_1 (calc.)	Q_{10}	$10^{-6}k$ (calc.)	Q_{10}
592.0	61.0	66.4		0.670	
603.5	90.6	98.4	1.50	0.667	0.996
627.0	204	222	1.50	0.647	0.987
651.0	485	489	1.53	0.693	1.029
656.0	568	561	1.51	0.705	1.039

From 0 to 354°C the reaction of formation of NO₂ has a negative temperature coefficient or a fractional value for Q_{10} (98, 559).

DECOMPOSITION OF PHOSGENE



[CO] and [COCl₂] are of the same order of magnitude (10⁻³ to 10⁻⁴).

Manometric method; units: minutes and M/l; $\log_{10} k = \frac{-11\,420}{T} + 15.154$; $\log_{10} K_E = \frac{-5850}{T} + 5.50$; homogeneous gas reaction (110).

$T, ^\circ\text{K} \dots \dots \dots$	655	685	715	745	782
$100k$ (obs.) $\dots \dots \dots$	0.53	2.95	15.1	67.6	354.0
$100k$ (calc.) $\dots \dots \dots$	0.52	3.03	15.2	66.8	354.0

SUMMARY OF GAS REACTION DATA ACCORDING TO TRAUTZ (516)

Units: seconds and M/cm³

$$\text{Second-order: } \log_{10} k = \frac{-A'}{T} + \frac{1}{2} \log_{10} T + J'$$

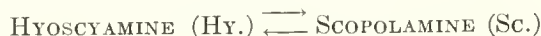
Reaction	A'	J'	Authority
H ₂ + O ₂ → H ₂ O.....	10 141	12.7	Bodenstein
H ₂ + I ₂ → 2HI.....	8 640	13.7	Bodenstein
2HI → H ₂ + I ₂	9 630	13.4	Bodenstein
HI + O ₂ → H ₂ O + I ₂	5 600	11.9	Trautz and Helmer
N ₂ + O ₂ → NO.....	18 800	11.4	Nernst and Jellinek
2NO → N ₂ + O ₂	13 700	10.3	Nernst and Jellinek
2O ₃ → O ₂	5 760	14.1	Warburg
NO + Cl ₂ → NOCl ₂	4 220	12	Trautz and Schlueter
NOCl ₂ + NO → NOCl.....	3 940	12	Trautz and Schlueter
2NOCl → NO + NOCl ₂	6 040	12	Trautz and Schlueter

$$\text{Third-order: } \log_{10} k = \frac{-A'}{T} - \log_{10} T + J'$$

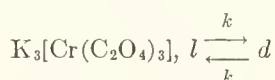
2NO + Cl ₂ → NOCl.....	1 220	14.6	Trautz, Wachenheim, Schlueter, Henglein
2NO + Br ₂ → NOBr.....	760	15.1	Trautz and Dalal

Additional references (86, 87, 88, 109, 116, 299, 440, 501, 502, 536).

Racemization

Polarimetric method; *t* in minutes; first-order reaction with reversal (194).1 g Hy. with absolute alcohol to 15 cm³ + 1 cm³ N NaOH; 2*k* = 0.0148 at 5°C.1.048 g Hy. with absolute alcohol to 24.95 cm³ + 0.5238 g tropine; 2*k* = 4.97 × 10⁻⁶ at room temperature.4.0173 g Sc. with absolute alcohol to 70 cm³ + 8.51 cm³ absolute alcohol containing 0.004017 mole NaOH; 2*k* = 0.0295 at 3°C.15.519 g alcohol solution of Sc. (of which 1 cm³ ≈ 9.46 cm³ 0.01N H₂SO₄) + 0.3736 g tropine; 2*k* = 4.42 × 10⁻⁶ at room temperature.The reaction is useful for determining [OH⁻].

POTASSIUM CHROMOXALATE

Polarimetric method; *t* in seconds (420); cf. (277, 513, 549)

In H ₂ O....	°C.....	0	11	22	24	<i>Q</i> ₁₀	<i>E</i>
	2 × 10 ⁶ <i>k</i>	149	239	542	598	1.77	9328
		% Acetone	H ₂ O, M/l	2 <i>k</i>			
In H ₂ O + Acetone, 22°C...		0	55.55	0.000542			
		40	33.33	0.000329			
		60	22.22	0.000262			

According to Beckmann (33) the two menthones are not optical antipodes and hence *k*₁ ≠ *k*₂.Measurements in various solvents; *k* independent of direction. Catalyzed by alcoholates, quaternary ammonium bases, and strong acids but not proportionally to their concentration.

Slight catalysis by weak acids. Not influenced by neutral salts, by acetic esters, or by dimethylhydroresorcinols. The catalysis by alcoholates is not influenced by slowly saponifiable esters but rapidly saponifiable ones react with Na from the alcoholates and decrease the reaction velocity accordingly.

Polarimetric method; *t* in minutes; catalyst, 0.02 (resp. 0.01N) alcoholate (resp. 0.01N HCl) (522, 523).

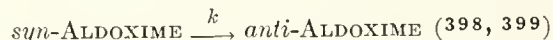
Solvent: alcohol	0.02N <i>k'</i> , 20°C	0.01N <i>k'</i> , 25°C	0.01N HCl <i>k'</i> , 20°C
Methyl.....	0.00317		0.0067
Ethyl.....	0.00826		0.0150
<i>n</i> -Propyl.....	0.0107		0.0215
<i>n</i> -Butyl.....	0.0130	0.0092	
<i>n</i> -Heptyl.....	0.0165		
<i>n</i> -Octyl.....	0.0191		0.0492
Isobutyl.....	0.0147	0.0105	0.0265
Isoamyl.....	0.0159		0.0277
Isopropyl.....	0.0171		
<i>sec</i> -Butyl.....	0.0336	0.0244	
<i>sec</i> -Octyl.....	0.0572		
<i>tert</i> -Butyl.....		0.0504	
Allyl.....		0.00200	0.0104
Benzyl.....		0.00118	0.0335

Values of 1000*k'* at 20°C in various solvents with 0.01N HCl

Solvent.....	C ₆ H ₆	C ₆ H ₄ (CH ₃) ₂	C ₆ H ₅ Cl	(C ₂ H ₅) ₂ O
10 ³ <i>k'</i>	2.3	2.0	6.9	0.4
Solvent.....	C ₂ H ₅ Br	CH ₂ BrCH ₂ Br	CCl ₄	CHCl ₃
10 ³ <i>k'</i>	3.4	10.8	5.3	47.1

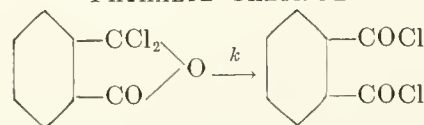
For all reactions *Q*₁₀ = 2.31–3.19; A' = 3250–4250.For determination of the "alcoholytic constant" of the type [acetoacetic ester]/[alcoholate]/[Na acetoacetic ester] = *K*, and for theory of the reaction, *v.* (225); cf. (10, 427).

Transformation of Geometric Isomers

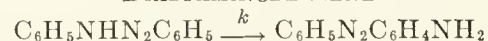
Method: change in rotation of the optically active solvent; *t* in minutes; *θ* = 20°C. 5 g oxime in 95 g solvent. Values of 1000*k*, (first-order):*syn*-Anisaldoxime in dimethyl tartrate (3.0); in diethyl tartrate (1.8); in di-*n*-propyl tartrate (1.0); in dimethyl malate (5.0); in diethyl malate (6.7); in di-*n*-propyl malate (8.4) (398); cf. (399).*syn-m*-Nitrobenzaldoxime in di-*n*-propyl tartrate (0.5) (398); cf. (399).

Intramolecular Transformation

PHTHALYL CHLORIDE

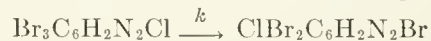
Reaction in liquid melt; method: initial freezing point; *t* in minutes; *k* (first-order) = 0.036 at 130°C; *Q*₁₀ = 1.6 (90 – 170°) (130).

DIAZOAMINO BENZENE

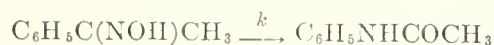
Gas-volumetric method; *t* in hours; solvent, aniline; catalyzed by C₆H₅NH₃Cl; rate proportional to concn. of catalyst, *C*_{cat}. (M/l); first-order *k* (216); cf. (204, 217).

°C.....	25			25	35	45	55	
<i>C</i> _{cat}	0.1	0.2	0.3	0.1				
10 ³ <i>k'</i>	6.0	12.3	18.1	6.0	24.6	81.0	253	A'
<i>Q</i> ₁₀					4.10	3.29	3.12	5355

TRIBROMOBENZENEDIAZONIUM CHLORIDE

Gravimetric method; *t* in minutes; solvent, methyl alcohol; first-order *k* (239); 10³*k'* = 0.83 at 0°C = 1.93 at 4°C; *Q*₁₀ = 8.2. The solid salt decomposes rapidly, the aq. soln. slowly, the alcoholic soln. at measurable rate (239).

ACETOPHENOXIME



Beckmann rearrangement; titrimetric method; t in minutes; catalyst, H_2SO_4 ; first-order k (490).

% H_2SO_4	68.5	93.6	94.6	97.2	98.2
$10^3k'$	60°C	1.1	1.3	4	7
	65°C	0.6	1.9	2.1	

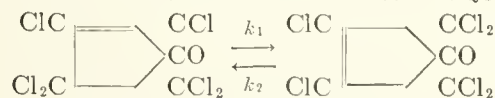
CINCHONINE OR CINCHONIDINE \xrightarrow{k} CINCHOTOXINE

Gravimetric and polarimetric methods; t in hours; solvent, aqueous acids (39, 40, 41, 42, 44). Cinchonine at $99.7 \pm 0.2^\circ\text{C}$; values of $1000k'$, (first-order); C_{cat} in M/l.

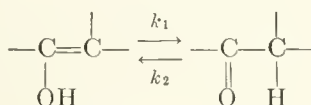
Cat.	$\text{C}_2\text{H}_5\text{CO}_2\text{H}$	$\text{CH}_3\text{CO}_2\text{H}$	HCO_2H	$(\text{CO}_2\text{H})_2$	HCl
C_{cat}					
0.15		5.60			1.63
0.175		7.12			0.77
0.20	11.7	9.4	6.2		0.3
0.40	29.6	23.9	12.1	4.0	
0.80	61.1	49.9	16.5		
2.00		90.1		0.7	

The value of k varies also with the initial concn. of the alkaloid. For theory of the reaction, *v.* (38, 39).

Tautomerism

HEXACHLORO- α -KETO- β -R-PENTENE IN THE LIQUID MELT

Gravimetric method; t in hours; first-order k , powerfully catalyzed by traces of H_2O or HCl . With material dried with P_2O_5 , $k_1 = 0.049$, $k_2 = 0.078$. $K_E = 1.59$ at 210.5°C (321, 322).

ENOL \rightarrow KETONE

First-order k ; t in minutes:

I = Ethyl acetoacetate, $\text{CH}_3\text{COCH}_2\text{CO}_2\text{C}_2\text{H}_5$.

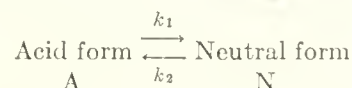
II = Methyl benzoylacetate, $\text{C}_6\text{H}_5\text{COCH}_2\text{CO}_2\text{CH}_3$.

III = Methyl mesityloxidoxalate, $(\text{CH}_3)_2\text{C}:\text{CHCOCH}_2\text{COCO}_2\text{CH}_3$.

Methods: (a) titration by Meyer's method; (b) bromine extraction; (331); *cf.* (138, 139, 141, 142); (c) viscosity; (d) refractometric; (e) FeCl_3 extraction; (f) FeCl_3 , colorimetric.

Ester	Solvent	k_1	k_2	$^\circ\text{C}$	Method	Lit.
I	Melt.....	0.0355	0.046	15	(a)	(368)
I	H_2O	2.4	0.010	0	(a)	
I			0.013	0	(b)	
I			0.039	10	(b)	
I	0.1N HCl.....		0.018	0	(b)	
I	Alcohol.....	0.077	0.0105	0	(a)	
I	Hexane.....	0.0041	0.0035	0	(a)	
I	Melt.....	$k_1 + k_2 = 0.034$		25	(c)	(158)
I		0.03172	0.037	Rm	(d)	(306)
I		$k_1 + k_2 = 0.0178$		Rm	(d)	
I		$k_1 + k_2 = 0.613$		Rm	(d)	
I		0.0397	0.042	Rm	(d)	
I		$k_1 + k_2 = 6.05$		Rm	(d)	
I	Petroleum ether.	0.0192	0.0073	15	(d)	
I	H_2O		0.017	0	(e)	(266)
II	Melt.....	$k_1 + k_2 = 1.3$		Rm	(d)	(305)
II	Alcohol.....	0.10	0.04	0	(a)	(367)
III	Melt.....	0.0085	0.033	98	(f)	(307)
III	Alcohol.....	0.0335	0.0417	78	(f)	
III		0.0455	0.052	Rm	(f)	

The reaction in the melt is very slow and depends on the nature of the walls, the presence of traces of impurities (*e.g.*, acids) and the previous history of the sample used. Acids are poor catalysts in H_2O and alcohol and good catalysts in non-ionizing solvents. The reaction in the gas phase is very slow even on the walls. For preparation of the pure tautomers, *v.* (370, 371).

HYDROXYTRIAZOLE \rightarrow DIAZOMALONIC ESTER

Method: iodine titration of the acid form; t in minutes; first-

order k . Methyl 1-methyl-5-hydroxytriazole-4-carboxylate $\xrightleftharpoons[k_2]{k_1}$

Methyl methylaminodiazomalonate. Ionization constant of the acid form = 2.8×10^{-3} .

Values for 50°C in various solvents (149)

	CH_3OH	$\text{C}_6\text{H}_5\text{CH}_2\text{OH}$	CH_3COCH_3
10^3k_1	0.120	0.278	1.36
10^6k_2	25.3	23.2	72.6
K_E	4.679	11.95	18.69

	$\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$	$\text{C}_6\text{H}_5\text{NO}_2$	$\text{C}_2\text{H}_5\text{ONO}_2$
10^3k_1	6.46	7.36	8.97
10^6k_2	117	73.6	98
K_E	54.25	100.0	98.9

$K_E = \frac{k_1}{k_2} = G \frac{S_N}{S_A}$ where S is the solubility (N- resp. A-form) in a given solvent and G is a universal constant independent of the nature of the solvent; *cf.* (260).

Values for 18°C in various solvents (149)

	CH_3OH	$\text{C}_6\text{H}_5\text{CH}_2\text{OH}$	CH_3COCH_3
K_E	3.27	8.62	14.15
S_N/S_A	6.29	13.28	20.82
G	0.52	0.65	0.68

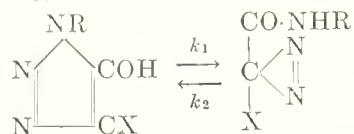
	$\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$	$\text{C}_6\text{H}_5\text{NO}_2$	$\text{C}_2\text{H}_5\text{ONO}_2$
K_E	51.63	99.0	89.91
S_N/S_A	84.61	157.7	171.3
G	0.61	0.63	0.53

Effect of solubility (g/l) on k_1 at 10°C . Methyl 1-phenyl-5-hydroxytriazole-4-carboxylate $\xrightleftharpoons[k_2]{k_1}$ Methyl anilindiazomalonate (149).

Solvent	k_1	S_A	S_N	$k_1 \times S_A$
CH_3OH	0.00053	218	34.4	0.116
$\text{C}_2\text{H}_5\text{OH}$	0.00103	97.7	29.1	0.101
$\text{C}_6\text{H}_5\text{CH}_2\text{OH}$	0.0011	90	222	0.099
CH_3CN	0.0047	41.5	194	0.195
CH_3COCH_3	0.00527	56.5	206	0.298
$\text{HCO}_2\text{C}_2\text{H}_5$	0.00828	23.3	257	0.193
CHCl_3	0.0211	8.8	572	0.186
$\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$	0.0267	12	194	0.320
$\text{C}_6\text{H}_5\text{NO}_2$	0.046	6.5	346	0.299
$\text{C}_2\text{H}_5\text{ONO}_2$	0.055	3.2	317	0.176

Results obtained in water as the solvent indicate that the non-ionized acid form is the reacting molecular species, *v.* (149).

Effect of Chemical Constitution



k_1 , measured; k_2 , calculated from K_E ; reaction in $\text{C}_2\text{H}_5\text{OH}$; values for very rapid or very slow reactions obtained by extrapolation to 25°C (149).

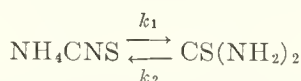
R	X	k_1	$10^5 k_2$	K_E
H.....	CONH_2	0.053	1.3	2.26
H.....	CO_2CH_3	0.0546	0.13	36
$\text{C}_6\text{H}_5\text{CH}_2$	CO_2CH_3	0.0426	0.22	118
$p\text{-C}_6\text{H}_4\text{CH}_3$	$\text{CO}_2\text{C}_2\text{H}_5$	0.0094	78	120
C_6H_5	CO_2CH_3	0.01	34	300
$p\text{-C}_6\text{H}_4\text{Br}$	$\text{CO}_2\text{C}_2\text{H}_5$	0.046	83	555
$p\text{-C}_6\text{H}_4\text{NO}_2$	CO_2CH_3	0.6		Very large

Effect of Temperature

Values of $10^5 k_1$ for $\text{R} = \text{C}_6\text{H}_5\text{CH}_2$ and $\text{X} = \text{CO}_2\text{CH}_3$ (149)

Solvent	40°C	50°C	60°C	Q_{10}
CH_3OH		6.35	9.59	3.5
$\text{C}_2\text{H}_5\text{OH}$		10.0	42.3	4.2
CH_3COCH_3	15.2	65.1		4.3
CHCl_3	61.8	172		6.5

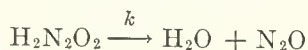
AMMONIUM THIOCYANATE



Reaction in the melt; titrimetric method; first-order k ; t in minutes; at 170°C , $k_1 = 0.015$, $k_2 = 0.044$, $K_E = \frac{1}{3}$ (25, 415, 528).

Decomposition Reactions

NITRAMIDE



For preparation of nitramide, *v.* (512). First-order k ; t in minutes; solvent, water; all values at 15°C (93).

$k = k_0 + k_c C_{\text{cat}}$, where k_0 is the constant for the uncatalyzed reaction and k_c that with a catalyst of concn. C_{cat} , M/l. All substances which decrease the $[\text{H}^+]$ of the solution act as catalysts. $k'_0 = 366$ to 398×10^{-6} , mean = 0.0338 .

Catalysis Constants for Anions of Acids

Values of k_c for the anions of weak monobasic acids, and their relation to the ionization constants, k_D

Acid	k'_c	$100k_D$	$10^5 k'_c \times k_D^{0.83}$
Propionate.....	0.65	0.00134	5.9
Acetate.....	0.50	0.0018	5.8
Phenylacetate.....	0.23	0.0053	6.5
Benzoate.....	0.19	0.0065	6.3
Formate.....	0.082	0.021	7.2
Salicylate.....	0.021	0.1	6.2
Dichloroacetate.....	0.0007	5.0	5.8
			Mean: 6.2

In the case of polybasic acids the value of k_c for each anion was found to be similarly related to the corresponding ionization constant when the latter is corrected by a "statistical" factor, n , as illustrated below. The subscripts 1 and 2 refer to the first and second ionization stages, respectively.

Catalysis Constants for Anions of Acids.—(Continued)

Acid	$10^3 k_{D1}$	n	k'_{c1}	$10^5 k'_{c1} (n k_{D1})^{0.83}$	$10^5 k_{D2}$	n	k'_{c2}	$10^5 k'_{c2} (n k_{D2})^{0.83}$
Succinic.....	0.065	$\frac{1}{2}$	0.320	6.0	0.21	2	1.8	6.2
Malic.....	0.40	$\frac{1}{2}$	0.0765	6.4	0.69	2	0.72	6.8
Tartaric.....	0.97	$\frac{1}{2}$	0.0363	6.3	3.7	2	0.165	6.2
Phthalic.....	1.2	$\frac{1}{2}$	0.029	6.2				
Oxalic.....				4.5		2	0.104	4.8
Phosphoric.....	8.9	$\frac{1}{3}$	0.0079	6.3	0.0049	1	86	7.2
			Mean: 6.2				Mean: 6.2	

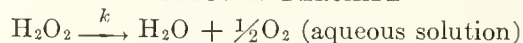
Catalysis Constant for Bases

The "acid" equilibrium constant of the base, RNH_2 , is $k_B = [\text{RNH}_2][\text{H}^+]/[\text{RNH}_3^+]$

	Aniline	Quinoline	Dimethyl-aniline	Pyridine
$10^5 k_B$	2.0	1.2	0.63	0.44
k'_c	0.531	1.9	2.7	4.6

For applications of the nitramide method to the determination of the ionization constants of (a) weak acids, (b) unsymmetrical dibasic acids, (c) H_2CO_3 (true constant), and (d) pseudo acids, *v.* (93).

HYDROGEN PEROXIDE



Homogeneous Catalysis

Catalysis by Alkalies

First-order k ; t in minutes; $\theta = 40^\circ\text{C}$ (100)

[NaOH].....	0.0004	0.0016	0.008	0.04	0.16
$10^3 k$	0.896	1.67	3.06	4.51	7.90
Base, 0.04 <i>N</i>	NaOH	KOH	NH ₄ OH	Ba(OH) ₂	
$10^3 k$	4.51	4.68	3.98	2.26	

Effect of temperature in 0.04*N* NaOH

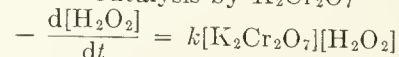
$^\circ\text{C}$	20	30	35	40	45	50	60	70
$10^3 k$	1.06	3.08	5.16	7.90	13.4	17.3	38.9	58.8
Q_{10}		2.9	2.6		2.2		2.2	1.5

Catalysis by Iodide Ion

According to Abel (3), the reactions are $\text{H}_2\text{O}_2 + \text{I}_2 \longrightarrow 2\text{H}^+ + 2\text{I}^- + \text{O}_2$ [for kinetics, *v.* (5)] and $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{I}^- \longrightarrow 2\text{H}_2\text{O} + \text{I}_2$. For t in minutes; first-order $k_{\text{cat}} = k[\text{I}^-]$. At 25°C , $k = 1.33$ (84, 534); *cf.* (89); = 1.4 (3); = 1.38 (241).

Neutral salts alone have slight influence. In the presence of iodide their pronounced catalytic effects increase in the order K^+ , Na^+ , Li^+ (241, 537, 538, 540).

In cases where the H_2O activity is constant, this catalysis by a neutral chloride is related to the Cl^- -activity, *a*, by the simple rule, $k_{\text{cat.}}/a = \text{constant}$, for the same salt concentration (240).

Catalysis by $\text{K}_2\text{Cr}_2\text{O}_7$ 

t in minutes; $\theta = 25^\circ\text{C}$; $k = 20.9$ to 34.5 in the interval

$[\text{K}_2\text{Cr}_2\text{O}_7] = 0.009$ to 0.043 (494); *cf.* (421, 495).

Heterogeneous Catalysis

By Colloidal Platinum

First-order k ; t in minutes; $\theta = 25^\circ\text{C}$; Pt, 1 to 31 500 (76, 79), effect of age of Pt soln.

Pt-soln., days old.....	0	1	5
k'	0.023	0.025	0.022
k' (with Na_2HPO_4 , 1 to 2000)....	0.015	0.016	0.012

Effect of concentration of Pt soln.; $k = \text{constant} \times [\text{Pt}]^n$ where n is a constant dependent upon the nature of the Pt preparation.

$1.13 \times 10^6 [\text{Pt}]$	32	24	16	12	6	4	3
$n = 1.58$ $10^3 k' (\text{obs.})$	115	72	40	24	8.4	4.6	2.7
$10^3 k' (\text{calc.})$	115	74	39	24	8.2	4.3	2.7

Effect of Poisons

The catalytic action of colloidal Pt is diminished by various "poisons" most of which are likewise physiological poisons. With certain of these poisons the catalyst, toward the end of the reaction, partially "recovers" from the effects. This is illustrated by the following table for HCN on $[\text{Pt}] = 1.03 \times 10^{-5}$.

$10^6 [\text{HCN}]$	0	0.05	0.1	0.2	0.5	1	2
$10^2 k'$, (begin).....	4.1	1.6	1.3	0.75	0.33	0.20	0.15
$10^2 k'$, (end).....	4.1	2.4	1.5	0.86	0.36	0.29	0.35

List of "Poisons" (* = Partial Recovery)

Powerful "poisons:" HCN*, ICN, I₂, HgCl₂, H₂S, Na₂S₂O₃, CO*, P, PH₃, AsH₃, Hg(CN)₂, CS₂.

Moderate "poisons:" aniline, hydroxylamine, * Br₂, HCl, oxalic acid, amyl nitrite, As₂O₃, Na₂SO₃, * NH₄Cl.

Weak "poisons:" H₃PO₃, NaNO₃, HNO₂, pyrogallol, nitrobenzene, HF, NH₄F.

Inactive substances: dilute KClO₃, ethyl and amyl alcohols, ether, glycerol, turpentine, chloroform.

Positive catalysts, ("tonics"): formic acid, hydrazine, dilute HNO₃.

By Colloidal Palladium

First-order k ; t in minutes; $\theta = 25^\circ\text{C}$ (75)

[Pd]	[NaOH]	k	[Pd]	[NaOH]	k
0	1:33 000	0	1:13 200*	1:6 000	0.0073
1:100 000	1:33 000	0.003	1: 6 600	1:3 000	0.0045
1: 13 000	1: 6 000	0.014	1: 6 600†	1:3 000	0.001
1: 4 400	1: 3 000	0.016	1:16 800	1:6 000	0.013
1: 13 200	1: 6 000	0.0103	1:16 800‡	1:6 000	0.0010

Poisoned by: * $[\text{I}_2] = 0.5 \times 10^{-7}$; † $[\text{HgCl}_2] = 10^{-3}$; ‡AsH₃ saturated.

By Colloidal Gold Catalysis in Alkaline Solution, v . (80)

In all of the preceding cases, the H₂O₂ reacts according to a first-order heterogeneous reaction [v . (95.8, 378)] if the reaction at the boundary is rapid in comparison with the rate of diffusion.

By Platinized Platinum

$$k' = \frac{1}{t} \log_{10} \frac{a}{a-x} = 0.4343 \frac{SD}{\delta v}$$

D = diffusion coefficient; S = active surface; δ = thickness of diffusion layer; v = total volume, cm³; RPM = stirring rate, revolutions per min.; t in minutes; $\theta = 25^\circ\text{C}$ (83).

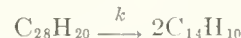
v	450	450	450	450	675	900	900	900	1350
RPM....	235	255	275	285	245	240	266	272	250
$10^4 k'$	60	67	74	80	46	39	42	39	20
Temp. interval, $^\circ\text{C}$	25-35		35-45		45-55				
Q_{10}	1.28		1.28		1.28				

By Mercury

For pulsating catalysis on Hg surface, v . (19, 68)

The thinnest Hg layer on gold which exhibits catalytic action is $\approx 3 \times 10^{-8}$ cm thick (85).

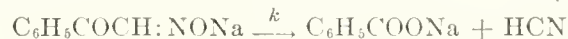
DIANTHRACENE \longrightarrow ANTHRACENE



Gravimetric method; first-order k ; t in minutes (349)

Solvent	$^\circ\text{C}$	$10^4 k$	Q_{10}
Phenetole.....	170	39.0	
	167	28.6	2.8
	160	13.9	2.8
Anisole.....	154	6.7	

The reaction is complete in the dark.



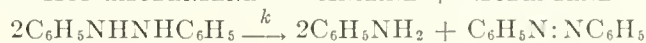
Colorimetric method; first-order k ; t in minutes (489)

In H ₂ O	$^\circ\text{C}$	35.6	60.1	69.0	70.0	Q_{10}
	$10^3 k'$	0.62	2.3	4.5	4.8	3.5

Effect of solvent at 60.1°C

Aqueous	$10^3 k'$	Solvent	$10^3 k'$
0.1N NaOH.....	1.4	50% C ₂ H ₅ OH.....	1.3
N NaOH.....	1.5	97% C ₂ H ₅ OH.....	1.0
N NaCl.....	1.5	97% CH ₃ OH.....	1.8
10N NaOH.....	2.2	100% CH ₃ OH.....	1.7

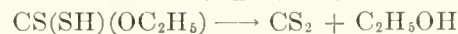
HYDRAZOBENZENE \longrightarrow ANILINE + AZOBENZENE



Titrimetric method; first-order k ; t in minutes (499)

In C₂H₅OH dried with Na, $k = 0.00156$ at 140.3°C . Authors conclude that free radicals are formed as intermediate step.

XANTHOGENIC ACID



Autocatalyzed by the alcohol. $\frac{dx}{dt} = (k + k_{ox})(a - x)$. At

the beginning of the reaction and in media where the reaction is rapid k_{ox} is negligible in comparison with k and the reaction is of first order.

Titrimetric method; t in minutes (233)

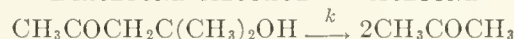
Solvent	k' , 0°C	k' , 25°C	A'
CS ₂		0.05132	
Ligroin.....	0.06190	0.05198	2500
Chloroform.....	0.0654	0.05480	2972
Benzene.....	0.0680	0.0568	3060
Nitrobenzene.....	0.0644	0.05415	3548
Ether.....	0.074	0.0564	3080
Acetone.....	0.00324	0.0343	3199
Alcohol.....	0.143		

Reaction in benzene-alcohol mixture of normality N with respect to alcohol; $\theta = 25^\circ\text{C}$ (233)

N	0	0.01	0.02	0.174	0.5	1.0
k'	0.068	0.04274	0.058	0.03294	0.0251	0.0423

For reaction in aqueous solution, v . (232).

DIACETONE ALCOHOL \longrightarrow ACETONE



In aqueous solution, the reaction is reversible, but for concentrations less than 10% it may be treated as complete. Dilatometric method; first-order k proportional to $[\text{OH}^-]$; t in minutes; $[\text{OH}^-]$ from conductivity; N = normality; $\theta = 25.2^\circ\text{C}$ (308).

N	NaOH		
	k'/N	$10^2 [\text{OH}^-]$	$k'/[\text{OH}^-]$
0.0942	0.2316	8.762	0.2490
0.0471	0.2357	4.503	0.2465
0.01884	0.2320	1.841	0.2375
0.00942	0.2358	0.929	0.2392
0.00471	0.2236	0.468	0.2250
0.002355	(0.1890)	0.235	(0.1894)

DIACETONE ALCOHOL \longrightarrow ACETONE.—(Continued)

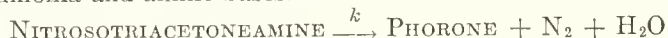
N	Ba(OH) ₂		
	k'/N	$10^2[\text{OH}^-]$	$k'/[\text{OH}^-]$
0.0942	(0.2161)	8.006	0.2544
0.0471	0.2300	4.192	0.2584
0.01884	0.2243	1.771	0.2386
0.00942	0.2301	0.918	0.2362
0.00471	0.2252	0.466	0.2276

The average of $k'/N = 0.2298$, and hence on the assumption of complete ionization, $dx/dt = 0.5292[\text{OH}^-] (a - x)$ at 25.2°C.

Effect of neutral salts

M/l	[NaCl]	0	0.471	0.942	1.413
[NaOH] = 0.0942..	$10^3k'$	21.81	18.90	16.93	15.67
[NaOH] = 0.0942..	Salt	NaCl	NaNO ₃	Na ₂ SO ₄	Na ₂ S ₂ O ₃
[Salt] = 0.942.....	$10^3k'$	16.93	15.59	22.87	20.79

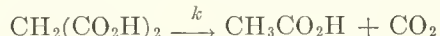
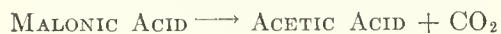
Method used to determine hydrolysis of Na₂CO₃ and ionization of ammonia and amine bases.



In aqueous solution with catalysis by OH⁻. Gas-volumetric and (more accurate) manometric method; first-order k , t in minutes (117, 184, 185, 186, 386). $k/[\text{OH}^-] = 1.92$ at 30°C; mean of 12 measurements between 0.016 and 0.020N OH⁻.

°C	18	30	40	50	60
$k/[\text{OH}^-]$, (obs.).....	0.612	1.92	4.51	10.15	22.0
$k/[\text{OH}^-]$, (calc. A = 8101)	0.637	1.92	4.51	10.06	21.3
Q_{10}		2.58	2.35	2.25	2.17

For application to determination of [OH⁻], v . (26); effect of neutral salts (21, 308); hydrolysis of soap solutions (350); acidity of Sn(OH)₄ solutions (123).

CO₂-Dissociation of Carboxylic Acids

Manometric method; first-order k ; t in minutes; medium: the melt, stable and undercooled (254)

°C*.....	153.6	153.2	143.5	142.3	136.4
10^3k	65.0	62.7	24.6	22.0	12.5

°C*.....	134.2	133.6	129.4	125.9
10^3k	10.15	9.58	6.39	4.58

* $Q_{10} = 2.6$ over the whole range.

For the solid acid, k is not constant, but a value k_s can be obtained by extrapolation to $t = 0$. In the following table this value is compared with the value, k , for the undercooled melt.

°C.....	126.3	125.3	121.2	117.3	110.8
10^3k_s	0.58	0.51	0.113	0.094	0.028
10^3k	4.77	4.42	2.91	2.00	1.08
k/k_s	8	9	26	21	39

Solvent: acetic acid (340)

°C*.....	98.5	99.1	99.4	100.0	102.5	104.5
10^3k	650	708	739	830	1150	1460

* $Q_{10} = 3.85$ over the whole range.

Values of 10^3k at 110.8°C in different media are: the solid acid, 0.028; the undercooled melt, 1.08 (254); acetic acid, 3.41 (340); H₂O, 3.62 (35, 36).



Titrimetric method; first-order k ; t in hours; solvent, H₂O (35, 36)

Malonic acid, CH₂(CO₂H)₂

°C.....	66.0	68.5	78.0	87.5	91.6	95.2	99.5
10^3k	0.27	0.9	4.4	16.4	28.8	47.3	75.5
°C.....	75.0	88.5	99.35	103.6	107.0	110.0	
10^3k	3.36	18.9	75.5	108.4	154.4	201.9	

Ethylmalonic acid, C₂H₅CH(CO₂H)₂

°C.....	80.0	86.0	95.0	102.0	105.0	110.0
10^3k	4.4	11.5	33.6	63.5	75.4	116.2

Benzylmalonic acid, C₆H₅CH₂CH(CO₂H)₂

°C.....	76.0	85.5	89.5	95.0	106.3	110.0
10^3k	14.3	48.6	83.3	116.1	259.0	476.5

Diethylmalonic acid, (C₂H₅)₂C(CO₂H)₂

°C.....	95.0	99.7	102.0	105.0	110.0
10^3k	9.1	35.5	55.5	73.0	122.5

Acid	Formula	k , 99.5°C
Phenylmalonic.....	C ₆ H ₅ CH(CO ₂ H) ₂	1.9
Benzylmalonic.....	C ₆ H ₅ CH ₂ CH(CO ₂ H) ₂	0.197
Chloromalonic.....	CHCl(CO ₂ H) ₂	0.18
Allylmalonic.....	CH ₂ :CHCH ₂ CH(CO ₂ H) ₂	0.132
Tartronic.....	CH(OH)(CO ₂ H) ₂	0.080
Malonic.....	CH ₂ (CO ₂ H) ₂	0.0757
Diallylmalonic.....	(CH ₂ :CHCH ₂) ₂ C(CO ₂ H) ₂	0.07
Methylmalonic.....	CH ₃ CH(CO ₂ H) ₂	0.06
Ethylmalonic.....	C ₂ H ₅ CH(CO ₂ H) ₂	0.051
Dichloromalonic.....	CCl ₂ (CO ₂ H) ₂	0.05
Di- <i>n</i> -propylmalonic.....	(C ₃ H ₇) ₂ C(CO ₂ H) ₂	0.05
Methylethylmalonic.....	(CH ₃)(C ₂ H ₅)C(CO ₂ H) ₂	0.035
Dimethylmalonic.....	(CH ₃) ₂ C(CO ₂ H) ₂	0.029
Diethylmalonic.....	(C ₂ H ₅) ₂ C(CO ₂ H) ₂	0.028
Dibromomalonic.....	CBr ₂ (CO ₂ H) ₂	0.02

ACETOACETIC ACID \longrightarrow ACETONE + CO₂

Both the undissociated acid (HA) and its anion (A⁻) undergo the reaction:

$$\frac{d[\text{CO}_2]}{dt} = k_1[\text{HA}] + k_2[\text{A}^-]$$

Let k_D = the ionization constant and α the degree of ionization of the aceto-acid, then

$$\frac{dx}{dt} = k_1[(1 - \alpha) + k_2\alpha](a - x)$$

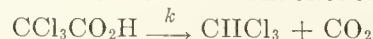
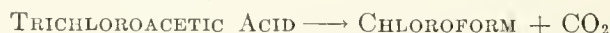
$$\frac{dx}{dt} = [k_1[\text{H}^+] + k_2k_D] \frac{(a - x)}{[\text{H}^+] + k_D}$$

k_1 is measured in strongly acid and k_2 in strongly alkaline solution. k_1 and k_2 together with a velocity measurement in an acetic acid-acetate solution give k_D . t in minutes (551); cf. (343). For preparation of the aceto-acid, v . (344).

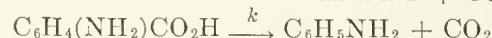
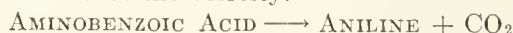
°C	10^3k_1	10^3k_2	10^3k_D	Q_{10}
25	0.99	0.02	0.316	3.53(k_1)
37	4.5	0.08	0.24	3.16(k_2)

Catalysis by Aniline

This reaction is of interest because, as in the case of many biochemical reactions, there is a maximum catalytic effect at a given [H⁺]. For details, v . (552).



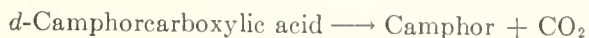
First-order k ; t in minutes; solvent, aniline (207). $10^3k = 0.040$ at 25°C; = 0.80 at 45°C; $Q_{10} = 4.47$. Addition of picric acid does not influence the velocity.



Titrimetric method; first-order k ; t in hours; solvent, H₂O; Temp. = B. P. of the solution (351)

Solution	10^3k
2 g Anthranilic acid in 150 cm ³ H ₂ O.....	27
3 g Anthranilic acid in 200 cm ³ H ₂ O.....	30
2 g <i>p</i> -Aminobenzoic acid* in 200 cm ³ H ₂ O.....	15

* *m*-Aminobenzoic acid does not react.



First-order k ; t in minutes (30, 69); reaction in aqueous solution; no catalytic effect by H^+ or OH^-

$^{\circ}\text{C}$	78	88	98	Q_{10}
10^3k for the undissociated acid.....	0.214	0.669	2.12	3.14
10^3k for the anion of the acid.....			0.063	

In C_6H_6 , $A =$	$^{\circ}\text{C}$	68	78	88	98
14 040	10^3k	0.305	0.958	2.91	8.48
	Q_{10}		3.14	3.04	2.91

At 98°C	In.....	$\text{C}_6\text{H}_5\text{NH}_2$	$\text{C}_2\text{H}_5\text{OH}$	C_6H_6
	10^3k	32.50	10.40	8.48

At 98°C	In.....	$\text{C}_6\text{H}_5\text{OC}_2\text{H}_5$	$(\text{C}_2\text{H}_5)_2\text{O}$	H_2O
	10^3k	7.36	3.02	2.12

In alcohol, esterification takes place also with a first-order $k = 0.0102$. Bases act as catalyzers; optically inactive bases act the same on the d - and the l -acids, but active bases act more powerfully on the d -acid (73, 75).

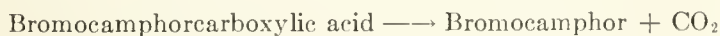
$^{\circ}\text{C}$	Solvent	10^3k	
		d -	l -
80	Aniline.....	6.76	6.63
80	Acetophenone.....	1.14	1.15
90		3.57	3.55
70	Nitrobenzene.....	0.333	
70	Nicotine.....	4.88	4.34
70	20 cm ³ Nitrobenzene + 1.02 cm ³ Nicotine....	3.02	2.79
70	10 cm ³ Acetophenone + 1.00 cm ³ Nicotine....	2.77	2.33
75	10 cm ³ Acetophenone + 1.65 g Quinidine.....	6.46	4.42

The dl -acid is made optically active by catalysis with an optically active base. The optical activity attains a maximum at the time,

$$t = \frac{1}{k_l + k_d} \log_e \frac{k_l}{k_d}$$

where k_l (resp. k_d), are the constants of the two isomers. For asymmetric synthesis, *v.* (74).

The catalytic action of bases in general can be interpreted in terms of two velocity constants, one for the free acid and one for its salt. For details, *v.* (77, 285).

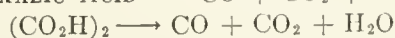
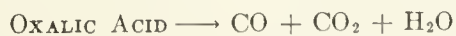


First-order k ; t in minutes (128, 128.5)

d - or l - acid in	$^{\circ}\text{C}$	60	70	80
Acetophenone	10^3k	2.16	5.03	12.1
	Q_{10}		2.37	2.40

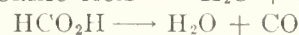
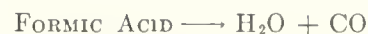
In ethyl benzoate as solvent the acid is polymerized (2x), and the decomposition is a second-order reaction. It is catalyzed by bases. Quinine catalyzes the l -acid; quinidine, the d -acid, more rapidly.

Dissociation of Carboxylic Acids with the Production of CO or HCO_2H



First-order k ; t in minutes; solvent, H_2SO_4 + various % H_2O . Even at 0°C the reaction is too rapid to be measured in H_2SO_4 containing 1% SO_3 (78, 338).

% H_2O	0.60	0.70	0.80	1.00	1.20	1.50	2.00	3.00
10^3k , 70°C	18.1	13.1	10.2	6.8	4.9	3.15	1.93	0.94
% H_2O	3.0	4.0	6.0	8.0	10.0	15.0	20.0	Q_{10}
10^3k , 98°C	23.7	14.6	6.9	4.0	2.22	0.73	0.294	3-4



First-order k ; t in minutes; solvent, 90% H_2SO_4 (365)

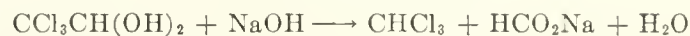
Reaction mixture; 0.610 g				Reaction mixture: m grams				
$\text{HCO}_2\text{H} + v \text{ cm}^3 \text{H}_2\text{SO}_4$				$\text{HCO}_2\text{Na} + v \text{ cm}^3 \text{H}_2\text{SO}_4$				
v	$^{\circ}\text{C}$	10^3k	Q_{10}	m	v	$^{\circ}\text{C}$	10^3k	Q_{10}
25	18	3.09	4.17	0.483	40	18	3.49	3.61
40	18	2.85		0.807	25	18	3.47	
40	25	8.44		0.512	40	25	8.68	
25	25	8.90		0.738	25	25	8.95	

Measurements by Schierz; same units (434)

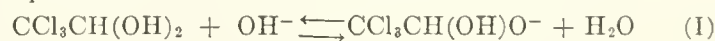
% H_2SO_4	98.9	97.6	94.5	91.8	89.2	85.0
$10^3k'$, 25°C	320.0	106.0	31.5	10.5	2.38	0.751
$10^3k'$, 15°C		32.6	9.9	3.29		
E		18 520	19 670	19 720		

In acetic anhydride as solvent the mixed anhydride $\text{CH}_3\text{CO}_2\text{OCH}$ is formed. For details of the reaction with various catalyzers, *v.* (535). For application of this reaction to the determination of acetic acid in acetic anhydride, *v.* (434).

CHLORAL HYDRATE



The equilibrium:



is rapidly established in alkaline solution and is followed by the slower reaction:



At low temperatures in strongly alkaline solutions the equilibrium (I) is displaced to the right and the net reaction is (II) with first-order k .

Titrimetric method; first-order k ; t in minutes; reaction mixture: 1 liter, composed of a moles chloral hydrate and b equivalents of base, the titer being T , hence

$$k' = \frac{1}{t} \log_{10} \frac{b - T_{\infty}}{T - T_{\infty}} \cdot [\text{OH}^-] = b - a$$

Measurements at 0°C , with KOH and with $a = 0.01$ (164)

b	b - a	k'	$k'/(b - a)$
0.012	0.002	0.0062	3.10
0.014	0.004	0.0134	3.35
0.016	0.006	0.0204	3.40

For the first solution ($k' = 0.0062$) we have therefore

$$\frac{d[\text{HCOO}^-]}{dt} = 7.1[\text{OH}^-][\text{CCl}_3\text{CH}(\text{OH})\text{O}^-] \text{ at } 0^{\circ}\text{C}$$

Neutral salts catalyze the reaction as in the case of sugar inversion by acids.

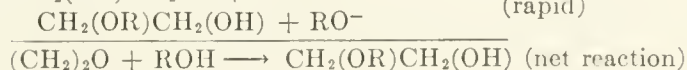
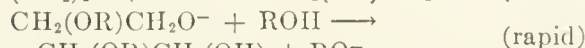
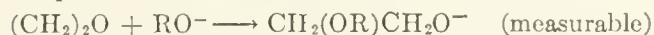
With increasing temperature ($Q_{10} = 5$), hydrolysis of the chloral salt increases and the constant k' exhibits a progressive decrease; *cf.* (57, 412, 548).

Addition Reactions

ADDITION OF PHENOLS TO OLEFIN OXIDES IN 98% ALCOHOL



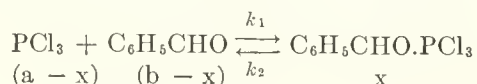
With pure phenol the reaction proceeds slowly, catalyzed by the phenolate (59, 60):



At constant concentration of phenol, k for olefin oxides is of first-order. Gravimetric method; t in hours; $[\text{ROH}] = 1$; $[\text{RONa}] = 0.05$; $\theta = 70.4^\circ\text{C}$ (59, 60). (I) k' for ethylene oxide = $0.4343k$; (II) k' for propylene oxide = $0.4343k$.

Phenol	(I)	(II)
Mesitol.....	0.375	
ψ -Cumenol.....	0.338	0.125
Thymol.....	0.311	0.107
<i>o</i> -4-Xylenol.....	0.305	
<i>m</i> -6-Xylenol.....	0.301	
<i>m</i> -Dimethylaminophenol.....		0.105
<i>p</i> -Cresol.....	0.279	0.101
Carvaerol.....	0.257	0.101
<i>m</i> -Cresol.....	0.256	0.083
2, 5-Dimethylphenol.....	0.244	0.092
Eugenol.....	0.226	0.080
<i>o</i> -Cresol.....	0.225	0.078
Phenol.....	0.205	0.075
α -Naphthol.....	0.173	0.083
Guaiacol.....	0.171	0.064
β -Naphthol.....	0.144	0.053
<i>p</i> -Chlorophenol.....	0.108	0.042
<i>o</i> -Chlorophenol.....	0.104	0.050
<i>m</i> -Chlorophenol.....	0.101	0.043
2, 4, 6-Tribromophenol.....	0.099	0.065
2, 4, 6-Trichlorophenol.....	0.075	0.045
<i>p</i> -Benzeneazophenol.....	0.050	0.023
<i>m</i> -Hydroxybenzonitrile.....	0.044	0.0224
Salicylic nitrile.....	0.033	0.0193
<i>m</i> -Nitrophenol.....	0.032	0.0152
<i>p</i> -Hydroxybenzonitrile.....	0.026	0.0150
<i>p</i> -Nitrophenol.....	0.013	0.0075
<i>o</i> -Nitrophenol.....	0.0073	0.0035

REVERSIBLE ADDITION OF PCl_3 TO BENZALDEHYDE (125)



$$\frac{dx}{dt} = k_1(a - x)(b - x) - k_2x$$

$$k_1 = \frac{K}{t\sqrt{q}} \log_e \frac{2Kx + m - \sqrt{q}}{2Kx + m + \sqrt{q}} \times \frac{m + \sqrt{q}}{m - \sqrt{q}}$$

$$m = -(Ka + Kb + 1)$$

$$q = (Ka + Kb + 1)^2 - 4K^2ab$$

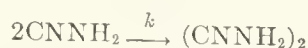
$$k_1 = k_2K$$

Concn. in M/l; t in hours; $\theta = 25^\circ\text{C}$; solvent: *nil* or benzene (125)

Benzene, cm ³	a = mole PCl ₃	b = mole C ₆ H ₅ CHO	10 ³ k_1	K
0	0.0573	0.0573	(0.56)	0.126
0	0.0573	0.1146	(4.60)	0.216
0	0.1146	0.0573	(0.71)	0.533
25	0.0226	0.0226	5.1	0.416
25	0.0226	0.0452	4.8	0.424
25	0.0452	0.0226	2.5	0.182
25	0.0452	0.0452	4.0	0.266

Average values in the benzene solution: $k_1 = 4 \times 10^{-3}$; $k_2 = 13.3 \times 10^{-3}$; $K = 0.3$.

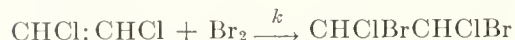
POLYMERIZATION OF CYANAMIDE TO DICYANDIAMIDE BY AQUEOUS ALKALIES



The velocity in 0.125*N* NaOH is a maximum (223, 224) which accords with the relation:

$$\frac{d[(\text{CNNH}_2)_2]}{dt} = k[\text{CNNH}][\text{CNNH}_2]$$

ADDITION OF BROMINE TO DOUBLE BONDS

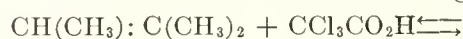
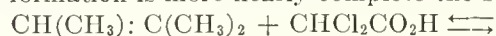


First-order k if the concn. of olefin as solvent is constant; t in hours; $\theta = 25^\circ\text{C}$ (249); cf. (31, 248).

Olefin	Formula	$k' = 0.4343k$
<i>cis</i> -Dichloroethylene.....	CHCl:CHCl	0.024
<i>trans</i> -Dichloroethylene.....	CHCl:CHCl	0.012
Tetraehloroethylene.....	CCl ₂ :CCl ₂	0.077

ADDITION OF OLEFINS TO ORGANIC ACIDS TO FORM ESTERS

Acetic acid scarcely reacts with amylene. The equilibrium is toward the side of the dissociation product. In general, ester formation is more nearly complete the stronger the acid.



Reaction with Excess of Amylene

The reaction is of the third-order with respect to the acid and runs to completion at low temperatures:

$$\frac{1}{V} \frac{dx}{dt} = k \left(\frac{1-x}{V} \right)^3$$

$$k' = \frac{1}{t - t_0} \left(\frac{1}{(1-x)^2} - \frac{1}{(1-x_0)^2} \right) = \frac{\text{constant}}{V^2}$$

Trichloroacetic Acid (382)

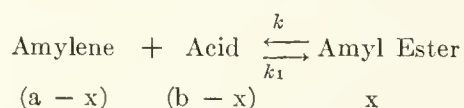
Titrimetric method; V = dilution per mole; t in minutes

Mole		V in cm ³	$^\circ\text{C}$	k'	$10^4 k' V^2$
Acid	Amylene				
1	6.8	915	28.7	0.037	3.10
1	15.75	1986	28.7	0.0079	3.12
1	4.124	595.6	31.2	0.127	4.50
1	7.663	1018	31.2	0.041	4.25

$$Q_{10} = 3.93$$

The acid which combines acts therefore simultaneously as a catalyst according to its second power.

Equilibrium Reaction



Both reactions are catalyzed by the acid according to the second power, hence

$$\frac{1}{V} \frac{dx}{dt} = \frac{k}{V^4} (a - x)(b - x)^3 - \frac{k'}{V^3} [x(b - x)^2]$$

Integration for $b = 1$ gives approximately

$$C = \frac{k(1 - \xi_1)^2 \xi_2^2}{V^3(\xi_1 + \xi_2)} = \frac{1}{t} \left[\log_e \frac{\xi_1(1 - x)}{\xi_1 - x} - (1 - \xi_1) \left(1 + \frac{1 - \xi_1}{\xi_1 + \xi_2} \right) \left(\frac{1}{1 - x} - 1 \right) \right]$$

where

$$\xi_1 = x \text{ for } t = \infty$$

$$\xi_2 = \frac{a}{\xi_1} \text{ for } t \text{ in minutes.}$$

Dichloroacetic Acid and Amylene at 100°C (382)

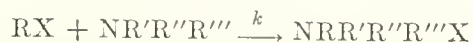
Mole		ξ_1	ξ_2	C , average
Acid	Amylene			
1	5.9	0.650	9.035	0.00234
1	8.03	0.682	11.77	0.00139
1	8.03	0.682	11.77	0.00138

Trichloroacetic Acid and Amylene at 100°C

1	9.51	0.86	11.06	0.0087
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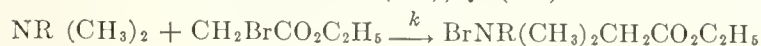
The formation of *isomeric* esters does not affect the calculation

FORMATION OF AMMONIUM SALTS FROM ALKYL HALIDES AND AMINES



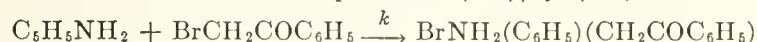
Second-order reaction: titrimetric method; units: minutes and M/l.

Addition of Amines to Ethyl Bromoacetate in Absolute Alcohol Soln. at 0°C (115); cf. (114)



Base	n	Values of 10 ³ k					
		2	3	4	5	6	7
C ₂ H ₅ (CH ₃) _n N(CH ₃) ₂		11.4	10.7	10.3	11.2	10.9	
(CH ₃) ₂ CH(CH ₂) _n N(CH ₃) ₂		9.7	9.9	10.6	10.6		
(CH ₃) ₂ N(CH ₂) _n N(CH ₃) ₂		9.5	16.8	24.9	20.8	24.5	27.5
CH ₃ O(CH ₂) _n N(CH ₃) ₂		6.7	9.3	10.6	10.5	11.5	

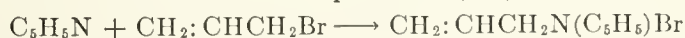
Addition of Aniline to ω-Bromoacetophenone in Various Solvents at Various Temperatures (127); cf. (126)



Solvent	10 ² k, 27.8°	Q ₁₀	10 ² k, 37.8°	Q ₁₀	10 ² k, 47.8°	E*
Ethyl ether.....	0.0607					
Benzene.....	0.0644	1.53	0.0985	1.52	0.150	8 088
Chloroform.....	0.0970	1.92	0.186	1.61	0.299	10 760
Nitrobenzene.....	0.617	2.19	1.35	1.87	2.52	13 470
Acetone.....	1.39	1.93	2.69	1.64	4.40	11 080
Benzyl alcohol.....	2.08	2.12	4.40	2.10	9.24	14 290
n-Butyl alcohol.....	2.67	2.06	5.50	2.10	11.6	14 060
Ethyl alcohol.....	2.90	2.16	6.26	1.98	12.4	13 910
Methyl alcohol.....	3.89	1.92	7.48	1.91	14.3	12 440

* Computed on the basis of R = 1.985.

Addition of Pyridine to Allyl Bromide in Various Solvents at Various Temperatures (244)

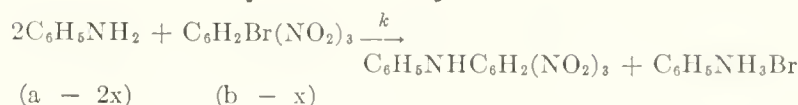


Solvent	10 ³ k, 28.3°	Q ₁₀	10 ³ k, 38.3°	Q ₁₀	10 ³ k, 56.5°	E
Toluene.....	0.231	2.25	0.517	1.97	1.86	15 100
Benzene.....	0.305	2.11	0.642	1.90	2.23	14 400
Ethyl alcohol.....	2.51	2.22	5.57	1.98	20.2	15 100
Acetone.....	5.05	2.02	10.2	1.82	33.8	13 600
p-Nitrotoluene.....	6.57	1.92	12.6	1.63	37.6	12 600
Acetophenone.....	10.4	1.95	20.3	1.42	52.6	12 100
Nitrobenzene.....	12.9	1.94	25.1	1.85	84.8	13 300

Mixed solvents; bimolecular k at 56.5°C

Mole		k	Mole		k
Acetone	Toluene		Acetophenone	Benzene	
1	0	0.0338	1	0	0.0526
0.88	0.12	0.0244	0.68	0.32	0.0340
0.75	0.25	0.0177	0.43	0.57	0.0203
0.59	0.41	0.0124	0.19	0.81	0.00913
0.40	0.60	0.00945	0	1	0.00227
0.23	0.77	0.00687			
0	1	0.00193			

Addition of Primary and Secondary Amines to Aromatic Halides



The effect of the C₆H₅NH₃Br formed upon the bromide is 100 times slower than that of the free aniline so that only the above reaction is significant.

Calculation of bimolecular k (416)

$$k = \frac{1}{2t} \times \frac{x}{b(b-x)} \text{ for } a = 2b$$

$$k = \frac{1}{(a-2b)t} \log_e \frac{b(a-2x)}{a(b-x)} \text{ for } a \sim 2b$$

Solvent: absolute alcohol; units: hours and M/l; θ = 50°C; values of 10²k (416)

Halide	Amine	
	C ₆ H ₅ NH ₂	C ₆ H ₅ NHCH ₃
C ₆ H ₃ Cl (1) (NO ₂) ₂ (2, 4).....	0.275	0.0295
C ₆ H ₃ Br (1) (NO ₂) ₂ (2, 4).....	0.421*	0.0869
C ₆ H ₃ I (1) (NO ₂) ₂ (2, 4).....	0.123	0.0212
C ₆ H ₂ Cl (1) (NO ₂) ₃ (2, 4, 6).....	1.90	0.0493
C ₆ H ₂ Br (1) (NO ₂) ₃ (2, 4, 6).....	3.31	0.269
C ₆ H ₂ I (1) (NO ₂) ₃ (2, 4, 6).....	1.72	0.668

* Mean of 7 determinations with the following extremes:

a	b	10 ² k
0.025	0.025	0.383
0.4	0.2	0.466

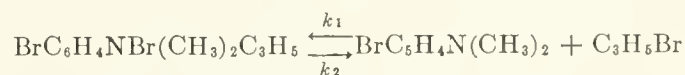
REVERSIBLE DECOMPOSITION AND FORMATION OF AMMONIUM AND SULFONIUM SALTS IN DIFFERENT SOLVENTS (229); cf. (230)

k₁ = first-order constant of decomposition.

k₂ = second-order constant of formation.

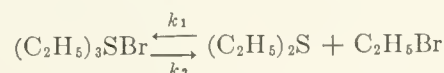
Titrimetric method; units: minutes and M/l; k'₁ = 0.4343 k₁.

Reversible Decomposition of p-Bromophenyldimethylallyl-ammonium Bromide



Solvent	10 ⁴ k' ₁		Q ₁₀	10 ⁴ k ₂		Q ₁₀
	25°	35°		25°	35°	
Tetrachloroethane...	0.78	3.8	4.8	17	29	1.7
Chloroform.....	0.27	1.42	5.3	5.5	10.2	1.9
Nitrobenzene.....	0.80					
Tetrabromoethane...	1.6					
Acetone.....		5.0				

Reversible Decomposition of Triethylsulfonium Bromide



Measurement at 25°C; the constant of formation, k₂, is corrected for the velocity of decomposition

Solvent	10 ⁴ k' ₁	10 ⁴ k ₂
Acetone.....	0.42	0.023
Acetone + 3.46% H ₂ O.....	0.04	0.035
Acetone + 7.11% H ₂ O.....	0	0.058

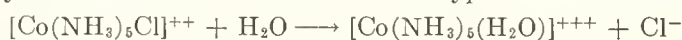
Decomposition of $(C_2H_5)_3SBr$, values of $10^4k_1'$

Solvent	A'	18°C	30°C	40°C	50°C	60°C	70°C	80°C	86°C	88°C	90°C	92°C	98°C
Tetrachloroethane.....	6680	0.072	0.59	2.89	13.4	55	230						
Nitrobenzene.....	6240	0.109	0.78	3.52	14.5	55	180						
Nitromethane.....	5990							47.0	90.0			171.0	
Ethyl acetoacetate.....	6460				12.8	49	194						
Amyl alcohol.....	7260				0.218	1.03	4.6	17.3			66		179
Propyl alcohol.....	7380					0.399	1.77	7.10			27.0		74.0
Benzyl alcohol.....	7459							3.9			15.9		47.0
Acetic acid.....	6087							3.5		8.0			26.5
Ethyl alcohol.....													26.5
Tetrabromoethane.....				3.8									

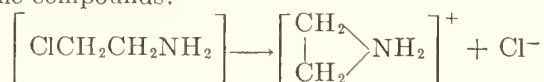
For the velocity of formation of $(C_2H_5)_3SI$, v , (106).

Coordination Reactions

By this is understood reactions of the type:



and the analogous reaction of alkyl halogen amines in forming heterocyclic compounds:

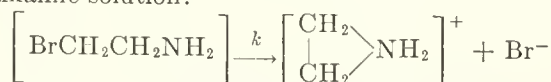


ALKYL HALOGEN AMINES (188, 189, 190, 192)

In alkaline media the first-order reaction runs to completion with the formation of a heterocyclic compound; in acid media the reverse reaction runs to completion; in neutral media the reaction reaches a measurable equilibrium but is accompanied by a side reaction.

Method: volumetric and coagulation of As_2S_3 sol; k , first-order; t in minutes.

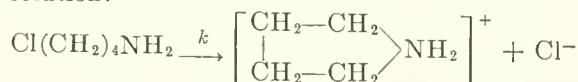
Conversion of β -Bromoethylamine into Ethyleneimine in aqueous alkaline solution:



°C.....	0	16.65	25
10^2k	0.068	0.89	2.9

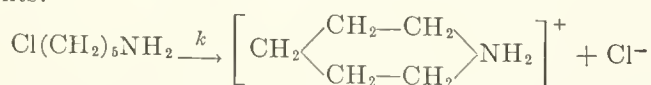
$$\log_e k = -\frac{12579}{T} + 38.770$$

Conversion of δ -Chlorobutylamine into Pyrrolidine in aqueous alkaline solution:



°C.....	0	25	Q_{10}
k	0.021	0.45	3.6

Conversion of ϵ -Chloroamylamine into Piperidine in various solvents:



The solvents immiscible with water were saturated with H_2O .

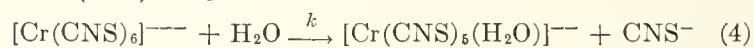
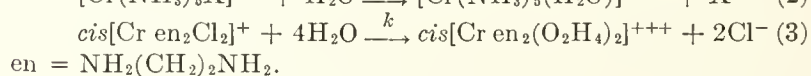
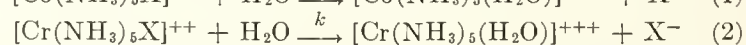
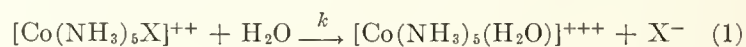
Solvent	10^2k , °C		
Aqueous alkali.....	0.029 (0°)	0.71 (25°)	2.98 (37°)
Ethyl alcohol, 91.2 Vol. %		0.10 (25°)	
Tetrachloroethane.....	0.019 (0°)	0.17 (24.8°)	0.45 (36.7°)
Nitrobenzene.....		0.13 (25°)	
Benzene.....		0.0049 (25°)	0.012 (36.1°)

$$\log_e k = -A/T + B$$

H_2O	Tetrachloroethane	Benzene
A = 10 440, B = 30.088	A = 7 231, B = 17.94	A = 7 575, B = 15.84

For the analogous reaction of $Br(CH_2)_5NH_2$ (resp. $I(CH_2)_5NH_2$) at 0°C in aqueous alkalies $k = ca. 0.02$ (resp. $ca. 2$).

KINETICS OF MONOMOLECULAR REACTIONS IN WATER

First-order k ; t in minutes

Reaction	X	k	°C	Lit.	Method
1	Cl	0.000132	25	(329)	(a)
1	Br	0.00039	25		
1	NO_3	0.00175	25		
2	Cl	0.00058	25	(188)	(b)
2	Br	0.003	25		
2	Cl	0.00002	0		
2	Br	0.00010	0		
2	I	0.01	0		
3		0.0032	25	(191)	(b)
3		0.00013	0		
4		0.00050	17	(47)	(c)

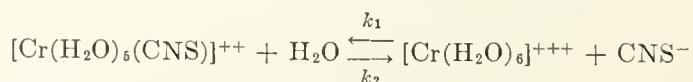
Reaction 1.—X = Cl: $\log_e k = -\frac{11067}{T} + 31.330$; $Q_{10} = 4.2$.

Reaction 2.—X = Cl: $\log_e k = -\frac{10890}{T} + 29.093$; $Q_{10} = 4.2$.

Reaction 3.— $\log_e k = -\frac{10430}{T} + 29.264$; $Q_{10} = 3.6$.

Methods: (a) = conductivity; (b) = coagulation; (c) colorimetric.

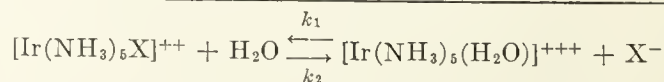
REVERSIBLE COORDINATION REACTIONS



$$\frac{dCNS^-}{dt} = k_1[Cr(H_2O)_5(CNS)]^{++} - k_2[CNS^-][Cr(H_2O)_6]^{+++}$$

Colorimetric method; units: minutes and M/l; solvent, H_2O (47)

	25°C	50°C
k_1	0.0000054	0.00040
k_2	0.0018	0.13



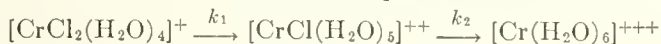
$$\frac{d[X^-]}{dt} = k_1[Ir(NH_3)_5X]^{++} - k_2[X^-][Ir(NH_3)_5(H_2O)]^{+++}$$

Conductivity method; units: hours and M/l; aqueous medium (327)

X	95°C		80°C	
	k_1	k_2	k_1	k_2
Cl.....	0.00231	0.118	0.0028	0.0151
Br.....	0.0081	0.076		
I.....	0.0081	0.054		
NO ₃	1.564	0.0475		

COORDINATION REACTIONS IN STAGES

The complete conversion of green dichlorotetraaquo chromic chloride $[\text{CrCl}_2(\text{H}_2\text{O})_4]\text{Cl}$ into blue hexaquo chromic chloride $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ takes place in dilute aqueous solution:



k_1 and k_2 are first-order constants.

Conductivity method; t in minutes; $\theta = 0^\circ\text{C}$ (46, 328). s = Concn. of HCl added, M/l. a = Initial concn. of green dichlorochloride, M/l; k_1 refers to the beginning ($t = 0$) and k_2 to the end of the reaction.

10 ³ s	10 ³ a	k_1 (obs.)	k_1 (calc.)	k_2	Lit.
0	3.22	0.187		0.008	(46)
0	10.74	0.107		0.0035	
0.415	9.99	0.0362	0.0365	0.00465	
1.015	3.56	0.0180	0.0183	0.0031	
1.015	10.81	0.0182	0.0180	0.00231	
2.050	10.07	0.0104	0.0105	0.00131	
10.22	3.22	0.0042	0.0043	0.00031	
10.22	8.52	0.0044	0.0043	0.00032	
10.20	9.65	0.0044	0.0043	0.00032	
10.34	9.98	0.0044	0.0043	0.00032	
0	7.930	0.143	(0.133)		(328)
0	7.987	0.144	(0.134)		
0	7.948	0.131	(0.134)		
0.0824	8.072	0.098	0.0967		
0.2000	7.978	0.066	0.0644		
0.844	8.045	0.0204	0.0211	0.0038	
0.878	8.033	0.0205	0.0205	0.0038	
0.999	8.016	0.0179	0.0187	0.0033	
1.005	7.935	0.0179	0.0185		
1.005	7.815	0.0186	0.0185		
1.005	7.950	0.0190	0.0185		
4.196	8.133	0.0064	0.00642	0.00080	
8.000	7.933	0.0047	0.00463	0.00050	
9.815	8.050	0.0042	0.00419	0.00032	
10.09	7.565	0.0042	0.00418		

Neutral salts have no significant influence. The influence of temperature is great. For k_1 , $Q_{10} = 4.80$ between 1 and 25° , = 3.80 between 20 and 25° ; for k_2 , $Q_{10} = 4.00$ between 20 and 25° (46).

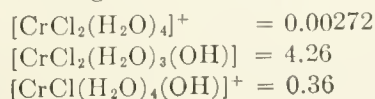
At 25°C , k_1 and k_2 are expressed by the equations:

$$k_1 = 0.00272 + \frac{0.0000162}{[\text{H}^+]} \quad (46)$$

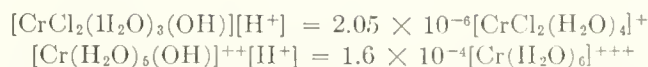
$$k_1 = 0.00265 + \frac{0.0000142}{[\text{H}^+]} \quad (328)$$

$$k_2 = \frac{3.1 \times 10^{-6}}{[\text{H}^+]} + \frac{5 \times 10^{-10}}{[\text{H}^+]^2} \quad (46)$$

k_1 and k_2 are aggregates of the velocity of conversion of the separate forms in which the reacting salts may appear. The hydrolytic forms act more rapidly than the ions. The first-order constants of the following forms have the values indicated (46):



According to Lamb and Fonda (328) the hydrolysis constants are:



The large temperature coefficients of k_1 and k_2 are caused by the great increase of hydrolysis with increasing temperature. The reaction: green chromic salt \rightarrow blue chromic salt is an example of the negative catalysis of hydrogen ion. For other work on negative catalysis, see (45, 514, 563).

Rearrangement of Dyestuffs and Indicators

CARBINOL FORM \rightleftharpoons QUINOID FORM

Colorimetric method; t in minutes; aqueous solution with 7% alcohol; first-order $k' = 0.0434 k$ (43); cf. (15, 38, 197, 236, 237, 374, 433).

Crystal violet: carbinol \rightarrow quinone; $Q_{10} = 2.75$

HCl, N	k' , 25°C	k' , 30°C	k' , 35°C	k' , 40°C
0.0026	0.1001	0.1688	0.2751	
0.0051	0.0249	0.0412	0.0726	0.1209
0.0068	0.0160	0.0261	0.0440	0.0730
0.0151	0.0096	0.0153	0.0255	0.0430
0.0234	0.0090	0.0150	0.0243	0.0399

Crystal violet: quinone \rightarrow carbinol: $Q_{10} = 2.04$

KOH, N	k' , 25°C	k' , 30°C	k' , 35°C	k' , 40°C
0.0033	0.0189	0.0263	0.0377	0.0535
0.0050	0.0290	0.0399	0.0570	0.0828
0.0083	0.0474	0.0651	0.0931	0.1334

Crystal violet: carbinol \rightarrow quinone, at 25°C

HCl, N	0.0432	0.0234	0.0151	0.0068	0.0051	0.0026
k'	0.01170	0.00899*	0.00969	0.01628	0.02482	0.10009

* Minimum at ca. 0.0234N HCl.

Malachite green at 25°C

HCl, N	0.065	0.023	0.015	0.007*	0.005	0.003
k'	0.1224	0.1092	0.0645	0.0480	0.0559	0.0628

* Minimum at ca. 0.007N HCl.

Phenolphthalein at 25°C

KOH, N	0.11	0.15	0.22	0.33
k'	0.0280	0.0420	0.0707	0.1048

The velocity of decolorization of triphenylmethane dyes increases with the concentration of alkali; with basic dyes it is proportional to the $[\text{OH}^-]$; with acid dyes (e.g., phenolphthalein) it increases with increasing $[\text{OH}^-]$ more rapidly than with the basic.

Retardation by neutral salts

Crystal violet in 0.013N KOH

Salt, N	0	0.1	0.2	0.3	0.4	0.5
k' (KNO ₃).....	0.0712	0.0520	0.0411	0.0350	0.0309	0.0259
k' (KCl).....	0.0712	0.0540	0.0440	0.0380	0.0328	0.0290

Crystal violet in 0.004N HCl

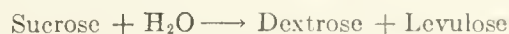
Salt, N	0.004	0.092	0.183	0.362
k' (KCl).....	0.0337	0.0163	0.0125	0.0105
k' (NaCl).....	0.0334	0.0186	0.0133	0.0105

Phenolphthalein in 0.31N KOH

NaCl, N	0	0.116	0.194	0.388	0.966	1.940
k'	0.1048	0.1204	0.1306	0.1451	0.1555	0.1625

Reactions of Sugars

INVERSION OF CANE SUGAR



Earlier investigations showed that the reaction with respect to sucrose is of the first order and that its velocity is proportional to $[\text{H}^+]$ (23, 119, 396, 497).

Polarimetric method: t in hours; concn. in M/l; $\theta = 27^\circ\text{C}$; catalyst, 57.50 g $\text{HCO}_2\text{H/l}$ (428, 429).

$$\frac{dx}{dt} = kW(S - x) \text{ where } W = [\text{H}_2\text{O}] \text{ and } S = [\text{C}_{12}\text{H}_{22}\text{O}_{11}]$$

g $\text{C}_{12}\text{H}_{22}\text{O}_{11}/\text{l}$	g $\text{H}_2\text{O}/\text{l}$	W	$10^4k'W$	$10^4k'(\text{obs.})$	$10^4k'(\text{calc.})$
400	705.4	39.15	58.1	1.484	1.485
300	768.52	42.65	57.0	1.337	1.335
200	829.60	46.04	54.4	1.182	1.203
160	855.52	47.48	54.8	1.156	1.152
140	887.60	48.15	53.8	1.117	1.128
100	892.82	49.54	53.9	1.088	1.081
60	916.86	50.88	53.1	1.044	1.039

$$k'(\text{calc.}) \text{ from } k' = 0.000490e^{-0.03049W}.$$

If $C_1, C_2 \dots$ equal the concentration of the substances which determine the nature of the medium, and $k_1, k_2 \dots$ equal the catalysis coefficients of these substances, the velocity coefficient, $k = k_0e^{k_1C_1+k_2C_2+k_3C_3+\dots}$.

Sugar inversion in 0.1N H_2SO_4 ; t in sec (284)

g $\text{C}_{12}\text{H}_{22}\text{O}_{11}/\text{l}$	MH $_2$ O/l	10^4k				Q_{10}		
		20°C	30°C	40°C	50°C	30/20	40/30	50/40
100	51.95	4.43	18.3	67.3	229	4.13	3.68	3.40
200	48.45	4.79	19.7	73.7	255	4.11	3.74	3.46
300	44.99	5.21	21.2	80.4	281	4.07	3.79	3.49
400	41.62	5.54	22.9	88.0	308	4.13	3.84	3.50
500	38.09	5.95	24.5	95.3		4.12	3.89	
600	34.59	6.22	25.8	102.2		4.15	3.96	
700	30.94	6.29	26.6	109.2	394	4.23	4.11	3.64

For formulation in terms of activities, see (372). Definition of activities according to (335); cf. (90, 243, 401, 433). For sugar inversion with subsequent mutarotation of glucose and fructose, see (362).

Effect of Pressure

Polarimetric method; p in atm.; $\theta = 25^\circ\text{C}$; catalyst, $\frac{1}{16}\text{N}$ HCl (121)

p	1	250	500	750	1000	1250	1500
$10^4k'(\text{obs.})$	243	231	220	210	197.5	190	181
$10^4k'(\text{calc.})$	(243)	233	222	212	202	191	(181)

$$k'(\text{calc.}) \text{ from } k' = a + bp.$$

Sugar inversion in 0.5N HCl in aqueous alcohol with 10% $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ (101).

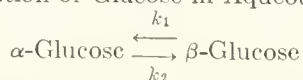
First-order $k'_1 = 0.4343k_1$, and second-order $k'_2 = 0.4343k_2$, the latter calculated under the assumption that H_2O acts according to the first power of its concentration. Polarimetric method; t in minutes; $\theta = 25^\circ\text{C}$.

Vol. % alcohol.....	0	16.7	25.0	40.0	50.0	60.0	75.0
$10^3k'_1$	2.19	2.13	2.04	1.92	1.76	1.85	2.08
$10^3k'_2$	4.27	4.91	5.19	6.07	6.67	8.77	16.03

For the use of sugar inversion to determine the hydrolysis of salts of weak bases, see (532, 533). For autocatalytic inversion by boric acid and its causes, see (55).

MUTAROTATION OR BIROTATION OF SUGARS

Mutarotation of Glucose in Aqueous Solution



$$k = k_1 + k_2 = \frac{1}{t} \log_e \frac{\xi}{\xi - x} = \frac{1}{t} \log_e \frac{\alpha_\infty}{\alpha_\infty - \alpha}$$

Polarimetric method; t in minutes; $\theta = 25^\circ\text{C}$.

$$k = k_w + k_a[\text{H}^+] + k_b[\text{OH}^-]$$

k_w	k_a	k_b	Lit.
0.0221	0.594	22 450	(272, 273, 274, 275, 394)
0.0239	0.769	21 520	(323, 324)

For further references on mutarotation of sugars, see (29, 170, 172, 334, 362, 377, 400, 422, 521, 524).

Decomposition of Pine Shavings by Caustic Soda in Autoclave under Pressure of 6–9 atm. at 140–170°C (24)

The velocity of decomposition of the shavings (52 % cellulose, 48 % non-cellulose) is proportional to the concn. of NaOH and to those of the dissolved portions of cellulose and non-cellulose.

k_i = first-order constant for the non-cellulose; t in hours

k_c = first-order constant for the cellulose

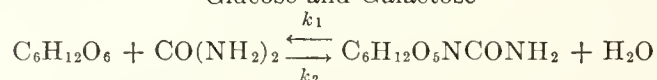
°C	k_i	k_c	$k_i:k_c$
140	1.94	0.069	28
160	5.34	0.430	12.4
170	8.47	0.976	8.7
270			1*
A	9 004	16 120	

* The value, $k_i:k_c = 1$ for 270°C is extrapolated from A.

Ureide Formation of Sugars in Aqueous Solution

Polarimetric method; units: M/l and hours; $\theta = 25^\circ\text{C}$; catalyst, N H_2SO_4 (435); cf. (526).

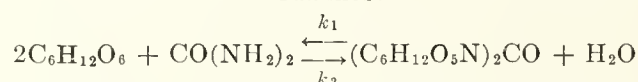
Glucose and Galactose



$$\frac{d[\text{Ureide}]}{dt} = k_1[\text{Sugar}][\text{Urea}] - k_2[\text{Ureide}]$$

Sugar	k_1	k_2
Glucose.....	0.00260	0.00153
Galactose.....	0.02435	0.00645

Mannose



Substance	Concentration		
	$t = 0$	$t = t$	$t = \infty$
Mannose.....	C_0	C	C_∞
Urea.....	C'_0	$C'_0 - \frac{1}{2}(C_0 - C)$	
Ureide.....	0	$\frac{1}{2}(C_0 - C)$	

$$\frac{-dC}{dt} = k_1C^2 \left\{ C'_0 - \frac{1}{2}(C_0 - C) \right\} - \frac{1}{2}k_2(C_0 - C)$$

$$\delta = \frac{1}{t} \left[\log_e \frac{(\beta - C_0)^2(\alpha + \gamma C + C^2)}{(\beta - C_0)^2(\alpha + \gamma C + C_0^2)} + \frac{2\beta + \gamma}{\sqrt{\alpha - \frac{1}{4}\gamma^2}} \frac{(C - C_0)\sqrt{\alpha - \frac{1}{4}\gamma^2}}{\text{arctg} \frac{(C - C_0)\sqrt{\alpha - \frac{1}{4}\gamma^2}}{(\alpha - \frac{1}{4}\gamma^2) + (C + \frac{1}{2}\gamma)(C_0 + \frac{1}{2}\gamma)}} \right]$$

$$\delta = k_1(\alpha + \beta\gamma + \beta^2), \alpha - \beta\gamma = \frac{k_2}{k_1}$$

$$\gamma - \beta = 2C_0 - C_0, \alpha\beta = \frac{k_2}{k_1}C_0, \beta = C_\infty$$

C_0	C'_0	C_∞	k_1	k_2	Lit.
0.4386	0.5	0.2074	0.0368	0.00527	(435)
0.4386	0.2412	0.2977	0.0367	0.00788	(526)

Hydrolysis or Saponification of Esters, Ethers and Acid Anhydrides



Influence of the concentration of the catalyst, HCl, on first-order k (in minutes), titrimetric method (330)

HCl, N	10^3k		Q_{10}
	25°C	35°C	
0.1005	0.653	1.663	2.547
0.5024	3.510	8.836	2.520
0.8275	6.001	15.26	2.542
1.800	16.09	37.84	2.353
2.429	20.78	63.47	3.054

Influence of concentration of ester, a , and of H_2O , w , upon hydrolysis constant (222)

$$\frac{dx}{dt} = k(a - x) \quad (1)$$

$$\frac{dx}{dt} = k_1(a - x)w - k_2x^2 \quad (2)$$

a^*	w	$10^3k(1)$	$10^3k/w$	$10^3k_1(2)$	$10^3k_2(2)$
Reaction in 1 <i>N</i> HCl at 25°C					
1.741	45.38	9.03	0.1991	0.1652	0.755
1.151	48.76	8.18	0.1679	0.1482	0.677
0.7093	50.94	7.64	0.1467	0.1392	0.636
Reaction in 0.1 <i>N</i> HCl at 25°C					
1.156	49.69	0.726	0.01461	0.01302	0.0595
0.7013	51.86	0.690	0.01330	0.01236	0.0565
0.2425	54.25	0.606	0.01217	0.01177	0.0538
0.1304	54.86	0.606	0.01104	0.01093	0.0499

* At still higher concentrations of ester, $k(1)$ increases with time.

Reaction in a viscous medium (water-gelatin) (104)

k = First-order constant for minutes and 18°C.

k_r = Constant reduced to the same H_2O concentration (unit: pure H_2O at 18°C).

η = Viscosity measured with Scarpa viscometer and referred to that of 0.5*N* HCl.

HCl, <i>N</i>	% Gelatin	η	10^3k	10^3k_r
0.5	0	1.000	2.116	2.138
0.5	1.348	1.480	2.025	2.061
0.5	3.354	3.692	1.698	1.747
0.5	5.152	8.976	1.747	1.813
0.5	9.642	20.23	1.593	1.696
0.2	0	1.000	0.7598	0.7628
0.2	9.627		0.6502	0.6876

Reaction in the presence of sugar (103)

$$k' = \frac{1}{t} \log_{10} \frac{\xi}{\xi - x}; k'_c = \frac{1}{tw} \log_{10} \frac{\xi}{\xi - x}$$

w = H_2O concentration; t in minutes; θ = 25°C; ξ = x for $t = \infty$

HCl, <i>N</i>	% Ester	% Sugar	w	$10^4k'$	$10^4k'_c$
0.5	5	0	52.32	14.97	28.6
0.5	5	7.5	49.60	16.6	33.5
0.5	5	15.5	46.88	17.5	37.3
0.25	5	0	52.35	7.16	13.63
0.25	5	7.5	49.83	8.05	16.16
0.125	5	0	52.67	3.50	6.64
0.125	5	7.5	49.95	3.99	7.99
0.5	2.5	0	53.72	14.81	27.6
0.5	5.0	0	52.32	14.97	28.6
0.5	10.0	0	49.60	15.94	32.1

For the determination of hydrolysis constants of salts of weak bases from the velocity of hydrolysis of $CH_3CO_2CH_3$, see (550, 556).



Effect of Salts on Acid Hydrolysis

First-order k (minutes); $k' = 0.4343k$

	Values of $10^5k'$ (507)			Q_{10}	Q_{10}
	0°C	25°C	40°C	$\frac{25}{0}$	$\frac{40}{25}$
0.1 <i>N</i> HCl	2.056	28.29	109.4	2.85	2.46
0.1 <i>N</i> HCl + 1 <i>N</i> KCl	2.480	34.45	132.9	2.86	2.46

Values of $10^5k'$ at 25°C in 0.1*N* HCl (241)

Salt	N	0	0.5	1.0	1.5	2.0	3.0
KCl		28.8	31.45	34.3	36.6	39.2	42.8
NaCl		28.8	31.75	35.9	39.9	42.85	52.3

Values of $10^5k'$ at 25°C in 0.05*N* acid (18)

Acid	HCl	HNO ₃	H ₂ SO ₄
$10^5k'$	13.84 ± 0.06	13.83 ± 0.11	10.11 ± 0.15

In each of the following determinations, the catalyst was 0.05*N* solution of the acid of the salt listed (18); cf. (436).

KCl, <i>N</i>	3.60	3.00	2.50	2.00	1.50
$10^5k'$	21.7	20.2	19.1	17.7	17.0
NaCl, <i>N</i>	4.80	4.08	3.40	2.72	2.04
$10^5k'$	29.7	27.4	25.4	22.9	20.2
NH ₄ Cl, <i>N</i>	4.77	3.98	3.31	2.65	1.99
$10^5k'$	22.8	21.3	20.7	19.5	17.8
BaCl ₂ , <i>N</i>	2.92	2.42	2.02	1.62	1.22
$10^5k'$	23.3	21.9	20.1	18.4	17.3
CaCl ₂ , <i>N</i>	10.10	8.42	7.02	5.60	4.20
$10^5k'$	55.9	50.7	45.2	38.2	30.4
MgCl ₂ , <i>N</i>	7.28	6.06	5.06	4.04	3.02
$10^5k'$	47.8	43.3	36.2	31.2	25.4
KNO ₃ , <i>N</i>	2.25	1.85	1.56	1.25	0.94
$10^5k'$	16.1	15.6	15.3	14.9	14.5
NaNO ₃ , <i>N</i>	5.82	4.68	3.90	3.12	2.34
$10^5k'$	21.4	18.9	18.0	17.3	16.3
NH ₄ NO ₃ , <i>N</i>	7.95	6.63	5.30	3.98	2.65
$10^5k'$	20.4	19.8	17.6	16.1	15.1
Ca(NO ₃) ₂ , <i>N</i>	7.70	6.42	5.32	4.28	3.20
$10^5k'$	22.1	20.5	19.4	18.3	16.9
Mg(NO ₃) ₂ , <i>N</i>	6.30	5.24	4.36	3.50	2.62
$10^5k'$	20.8	19.4	18.2	17.2	16.5
K ₂ SO ₄ , <i>N</i>	1.08	0.90	0.60	0.30	
$10^5k'$	3.4	3.5	3.6	4.0	
(NH ₄) ₂ SO ₄ , <i>N</i>	6.80	5.68	4.72	3.78	2.84
$10^5k'$	3.5	3.8	3.7	3.4	3.4
Na ₂ SO ₄ , <i>N</i>	1.92	1.60	1.07	0.53	
$10^5k'$	3.6	3.5	3.8	4.0	
MgSO ₄ , <i>N</i>	4.24	3.54	2.96	2.36	1.76
$10^5k'$	7.0	6.6	6.1	5.6	5.4

Catalyst, 0.03*N* HCl; 20°C; $10^5k' = 5.10$ (406)

<i>N</i>	KCl	NaCl	LiCl	BaCl ₂	SrCl ₂	MgCl ₂
1	6.39	6.37	6.36	6.31	6.30	6.42
0.6	5.95	5.94	5.90	5.88	5.86	5.88
0.3	5.45	5.45	5.46	5.43	5.42	5.50

Catalyst, 0.03*N* HBr; 20°C; $10^5k' = 4.94$ (406)

<i>N</i>	KBr	NaBr	BaBr ₂
1	5.80	5.94	5.91
0.6	5.53		5.53
0.3	5.23	5.25	5.22

Catalyst, 0.03*N* HNO₃; 20°C; $10^5k' = 4.93$ (406)

<i>N</i>	KNO ₃	NaNO ₃	Sr(NO ₃) ₂
1	5.33	5.37	5.34
0.6	5.11	5.16	5.26
0.3	5.02	5.06	5.11

For the determination of hydrolysis constants of salts of weak bases from the velocity of saponification of $CH_3CO_2C_2H_5$, see (555, 558).



Effect of concentration of NaOH and of neutral salts on k ; titrimetric method, second-order k ; units: M/l and minutes; $\theta = 24.7^\circ\text{C}$ (21)

NaOH, <i>N</i>	0.05	0.025	0.0125	0.00625	0.003125
k	6.76	6.52	6.48	6.58	6.65
0.025 <i>N</i> NaCl + <i>N</i>	NaCl	NaNO ₃	CH ₃ CO ₂ Na	Na ₂ S ₂ O ₃	Na ₂ SO ₄
k	5.75	5.06	6.50	6.63	7.31

Effect of nature of the alkali and temperature on k (369)

Base	LiOH	NaOH	KOH	RbOH	CsOH
k , 18°C	3.92	3.98	4.01	4.00	4.03
k , 25°C	6.12	6.17	6.20	6.22	6.22
Q_{10}	1.89	1.87	1.86	1.88	1.86

Effect of neutral salts on k (193)

Salt, N	0	0.5KCNS	1KCNS	0.5KCl	1KCl
k , 25°C	6.76	5.49	4.79	6.10	5.99

Various concentrations of salts at 25°C (498)

Salt*	4N	2N	1N	0.5N
KCl	4.688	5.307	5.673	5.913
KBr		4.550	5.292	5.665
KI	3.267	4.155	4.898	5.505
KNO ₃		5.978	5.356	5.666
K ₂ SO ₄			7.159	6.903
(CO ₂ K) ₂		7.136	6.790	6.636

* In absence of salt, $k = 6.510$

Effect of temperature (413)

°C	9.4	14.4	24.22	35.14	44.94
k (obs.)	2.307	3.204	6.151	12.096	21.648
k (calc.)	(2.307)	3.20	(6.151)	11.97	(21.648)

$$\log_{10} k = -1780/T + 0.00754T + 4.53.$$

Effect of pressure (122)

 k_t by titrimetric method; k_c by conductivity method, cf. (531);

$$p, \text{ pressure in atm.}; \Delta = \left(\frac{k_{p \text{ atm.}} - k_{1 \text{ atm.}}}{k_{1 \text{ atm.}}} \right) 100.$$

$$k = a + bp \quad (1)$$

$$\frac{d \log_e k}{dp} = \text{Constant} \quad (2)$$

Effect of pressure.—(Continued)

p	k_t	k_c	Δ	$k(1)(\text{calc.})$	$k(2)(\text{calc.})$
1	1.22	1.21		(1.21)	(1.21)
250	1.26		3.7	1.29	1.28
500	1.35	1.37	11.9	1.36	1.35
750	1.44		18.5	1.44	1.42
1000	1.52	1.53	25.5	1.52	1.50
1250	1.59		30.9	1.59	1.58
1500	1.67	1.67	37.4	(1.67)	(1.67)

Effect of blood charcoal (320); blood charcoal, Merek (purified with HCl); $\theta = 25^\circ\text{C}$

mgC/100cm ³	k	mgC/100 cm ³	k
0	6.26 ; 6.23	745.1	2.61 — 1.66
401.2	3.58 — 2.60	1066.0	1.99 — 1.49

Reaction in aqueous alcohol solution (312)

Vol. % C ₂ H ₅ OH	50	75	95	100
k , 25°C	1.62	0.668	0.136	0.00753

$\theta = 25^\circ\text{C}$; 96.4 Wt. % C₂H₅OH. The H₂O content = 3.6 Wt. % or 3.6 M/l if it is assumed that all the soda is present as NaOH (547); α = calc. degree of dissociation of NaOH (assuming the mass law to hold true) with 0.02 used as the NaOH dissociation constant:

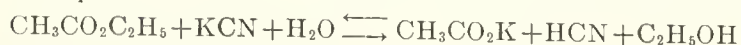
$$\frac{-d[\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5]}{dt} = [\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5][\text{NaOH}][0.12911(1 - \alpha) + 0.05710\alpha]$$

The undissociated base therefore saponifies more rapidly than its ions. The velocity increases greatly with increased water content of the alcohol. If the solution is prepared by dissolving metallic sodium and if the water content of the alcohol is not sufficient to combine all Na as NaOH, the bimolecular law no longer holds and the velocity is very small. This makes it probable that the saponification is entirely caused by NaOH and not by NaOC₂H₅; cf. in this connection (545, 546).

ALKALINE SAPONIFICATION OF ESTERS BY SALTS OF WEAK ACIDS

Slightly Hydrolyzed Salts (22, 26, 234, 325, 352, 369, 441, 479, 555, 557, 558)

Example:



$$\frac{dx}{dt} = kK \frac{(a-x)(b-x)}{x}; \text{ units: minutes and M/l.}$$

 k = Second-order constant of ester saponification by $[\text{OH}^-]$. $K_w = [\text{H}^+][\text{OH}^-]$ = constant = ion product of H₂O. K_s = dissociation constant of HCN. $K = \frac{K_w}{K_s}$ = hydrolysis constant of KCN.

Ester	°C	k	Salt	$10^5 kK$ (obs.)	$10^{14} K_w$	$10^5 K$ (calc.)	$10^{10} K_s$ (calc.)	Lit.
CH ₃ CO ₂ C ₂ H ₅	24.2	6.22	KCN	7.46	1.00	1.20	8.33	(441); cf. (22, 26, 325)
			C ₆ H ₅ OK	58.0	1.00	9.32	1.07	
			Na ₂ CO ₃	64.7	1.00	10.4	0.96	
CH ₃ CO ₂ CH ₃	25.0	10.2	C ₆ H ₅ ONa	86.7	1.00	8.50	1.18	(234)
			<i>p</i> -ClC ₆ H ₄ ONa	27.3	1.00	2.68	3.74	
			<i>o</i> -ClC ₆ H ₄ ONa	14.8	1.00	1.45	6.91	
			2, 4-Cl ₂ C ₆ H ₃ ONa	0.86	1.00	0.084	119.0	
			2, 4, 6-Cl ₃ C ₆ H ₂ ONa	0.438	1.00	0.0429	232.0	
			<i>p</i> -NaOC ₆ H ₄ NO ₂	0.25	1.00	0.025	400.0	
			<i>p</i> -NaOC ₆ H ₄ CN	0.878	1.00	0.0861	116.0	
CH ₃ CO ₂ C ₂ H ₅	25.0	6.86	Leucine-Na	40.0	1.00	5.81	1.72	(555)
			Glycine-Na	40.1	1.00	5.85	1.71	
			Alanine-Na	37.4	1.00	5.46	1.83	
CH ₃ CO ₂ C ₂ H ₅	10.3	2.29	KCN	2.58		1.128		(352)
			KCN	8.13		1.544		
			KCN	32.17		2.047		
CH ₃ CO ₂ CH ₃	25.0	11.42	Oxyuracil-Na	5.38	1.20	0.480	25.0	(557, 558)
			Allantoin-Na	11.7	1.20	1.03	11.7	
			Hydantoin-Na	18.0	1.20	1.58	7.59	
			Methyluracil-Na	43.5	1.20	3.82	3.14	

ALKALINE SAPONIFICATION OF ESTERS.—(Continued)

Ester	°C	<i>k</i>	Salt	10 ⁵ <i>kK</i> (obs.)	10 ¹⁴ <i>K_w</i>	10 ⁵ <i>K</i> (calc.)	10 ¹⁰ <i>K_s</i> (calc.)	Lit.
CH ₃ CO ₂ CH ₃	25.0	11.42	α-Dimethyluracil-Na.....	155.0	1.20	13.6	0.88	(557, 558)
			β-Dimethyluracil-Na.....	185.0	1.20	16.2	0.74	
			Succinimide-Na.....	453.0	1.20	3.97	0.302	
			Theobromine-Na.....	104.0	1.20	10.8	1.11	
			C ₆ H ₅ ONa.....	89.0	1.20	9.23	1.30	
			Theophylline-Na.....	8.45	1.20	0.741	16.2	
			Paraxanthine-Na.....	6.16	1.20	0.540	22.2	
CH ₃ CO ₂ C ₂ H ₅	18.0	3.98	NaCN.....	6.05		1.52		(369)
	25.0	6.17	NaCN.....	10.36		1.68		
CH ₃ CO ₂ CH ₃	25.0	10.74	Na ₂ CO ₃	110.0	1.00	10.2	0.977	(479)

The following values of *Q*₁₀ hold for the constants *kK* and *k* of the reaction CH₃CO₂C₂H₅ + KCN, according to (352, 369):

°C.....	10.3–25.05	25.05–41.8	18–25	Mean
<i>Q</i> ₁₀ for <i>kK</i> = <i>τ'</i>	2.18	2.28	2.16	2.20
<i>Q</i> ₁₀ for <i>k</i> = <i>τ</i>	1.90	1.79	1.87	1.85

The relation between *τ'* and *τ*, according to (447, 449) is given by:

$$\log \frac{\tau'}{\tau} = \frac{10U}{RT(T + 10)}$$

where *U* is the heat of the reaction OH[−] + HCN = H₂O + CN[−], which is considered constant over the temperature range 10°.

Strongly Hydrolyzed Salts

For the theory of the reaction, see (347).

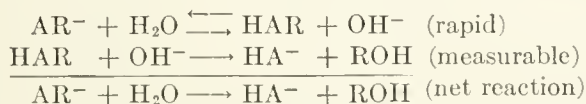
Saponification of CH₃CO₂C₂H₅ by NaOH in the presence of sugars (120)

The following velocity constants were found at 25°C (*k* = 6.86), in the presence of sugars or high-order alcohols in *N*/40 solution of ethyl acetate and NaOH:

Sugar \ <i>N</i>	1/5	1/10	1/20	1/40	1/80
Cane sugar.....	2.01	3.12	4.29	5.19	5.88
Invert sugar.....	0.38	0.67	1.17	2.08	3.38
<i>d</i> -Glucose.....	0.79	1.37	2.32	3.69	4.79
<i>d</i> -Fructose.....	0.59	1.02	1.88	3.04	4.27
Mannitol.....	5.17	5.85	6.18	6.40	6.81

From this may be calculated the degree of hydrolysis of the corresponding sugar solution.

ALKALINE SAPONIFICATION, IN AQUEOUS SOLUTION, OF ESTERS (GENERAL FORMULA HAR) WHICH ARE THEMSELVES WEAK (RESP. PSEUDO) ACIDS



$$\frac{dx}{dt} = k[\text{HAR}][\text{OH}^-] = k[\text{IAR}] \frac{K_w [\text{RA}^-]}{K_s [\text{HAR}]} = k_1 [\text{RA}^-].$$

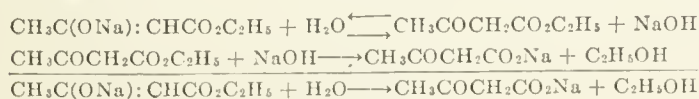
$$k_1 = k \frac{K_w}{K_s} = \text{First-order constant.}$$

k = Second-order constant of alkaline saponification of HAR.

$$K_w = [\text{H}^+][\text{OH}^-] = 1.3 \times 10^{-14}.$$

K_s = Dissociation constant of the weak acid, HAR.

Example:



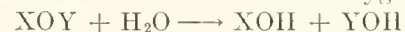
The disubstituted acetic acid ester which forms no salts with NaOH behaves as a normal (*i.e.*, neutral) ester (215, 218, 343, 359).

Titrimetric method; *θ* = 25°C; units: minutes and M/l

Ester	<i>k</i> ₁	10 ¹¹ <i>K_s</i>	<i>k</i>	Lit.
CH ₃ COCH ₂ CO ₂ CH ₃	0.0279	2.0	43.0	(343)
CH ₃ COCH ₂ CO ₂ C ₂ H ₅	0.0186	2.0	28.6	(215, 218)
CH ₃ COCH(C ₂ H ₅)CO ₂ C ₂ H ₅ ..		0.09	10.0 <i>ca.</i>	
CH ₃ COC(CH ₃) ₂ CO ₂ CH ₃			2.43	
CH ₃ COC(CH ₃) ₂ CO ₂ C ₂ H ₅			0.76	(359)
CH ₃ COC(C ₂ H ₅) ₂ CO ₂ C ₂ H ₅ ...			0.0058	(215, 218)

THE THREE CONSTANTS OF SAPONIFICATION IN AQUEOUS SOLUTION

If (*a* − *x*) is the concentration of the ester, organic acid anhydride or ether, all of which have an "ether oxygen," then:



Where X and Y represent alkyl or acyl, the general velocity equation is:

$$\frac{dx}{dt} = (k_w + k_s[\text{H}^+] + k_a[\text{OH}^-])(a - x)$$

where *k_w* = constant for water saponification, *k_s* for acid saponification, and *k_a* for alkaline saponification.

The units for all the constants quoted in the following are minutes and M/l.

For references on the general equation, see (92, 456, 476, 541, 542). For methods of determining *k_s* and *k_a* by means of buffer salts, see (423, 450, 451, 454, 458, 460, 467, 470, 476, 478, 479, 480, 481, 485).

Esters and ethers of polybasic acids and of poly-alcohols saponify in stages. As a rule, with esters of polybasic acids, the constant of the second saponification stage, *k_s*, holds for the undissociated ester-acid, and *k_a* for its anion.

Esters and ethers of poly-alcohols with dissimilar groups yield isomeric intermediate products. The latter, under the catalytic influence of acids and bases are capable of changing from one to the other; *cf.* (487).

If the velocities for different types of esters or ethers are to be intercompared, such comparison must be made through the "group constants;" that is, the constants reduced to the bases of a single "ether oxygen."

If the group constants of a poly-ester or ether are the same, the following simple relation holds: The velocity is directly proportional to the number of saponifiable groups present.

For the determination of the constant of the intermediate stages from the total net reaction, see the fundamental work of Wegscheider (544).

Influence of Temperature upon Acid Saponification of Esters;
Titrimetric Method

Ester	$10^3 k_a$			Q_{10} $\frac{25}{25}$	Q_{10} $\frac{50}{50}$	Lit.
	25°	35°	50°			
CH ₃ CO ₂ C ₂ H ₅	6.77	15.93	49.69	2.35	2.14	(150)
CH ₂ ClCO ₂ C ₂ H ₅	4.58	9.17	32.12	2.00	2.31	
CH ₂ (CN)CO ₂ C ₂ H ₅	1.025	2.31	7.69	2.26	2.23	
CH ₃ CH ₂ CO ₂ C ₂ H ₅	7.04	17.7	53.38	2.51	2.09	
CH ₃ CHBrCO ₂ C ₂ H ₅	2.106	3.89	9.25	1.84	1.78	
CH ₃ CHClCO ₂ C ₂ H ₅	2.85	5.69	18.74	2.00	2.21	
CH ₂ ClCH ₂ CO ₂ C ₂ H ₅	0.975	2.39	8.61	2.45	2.35	
CH ₂ BrCH ₂ CO ₂ C ₂ H ₅	0.815	2.16	5.45	2.65	1.85	

Ester	$10^3 k_a$			Q_{10} $\frac{35}{25}$	Q_{10} $\frac{45}{35}$	Lit.
	25°	35°	45°			
CH ₃ CO ₂ C ₂ H ₅	6.37	16.26	37.4	2.55	2.30	(155)
CH ₂ (OH)CO ₂ C ₂ H ₅	6.83	16.62	38.5	2.43	2.32	
CH ₂ (OCH ₃)CO ₂ C ₂ H ₅	3.80	9.00	22.6	2.37	2.51	
CH ₂ (OC ₂ H ₅)CO ₂ C ₂ H ₅	3.56	8.75	21.7	2.46	2.48	
CH ₂ (OC ₃ H ₇)CO ₂ C ₂ H ₅	3.52	8.40	21.2	2.39	2.52	
CH ₃ CO ₂ C ₂ H ₅	6.47	16.3	37.4	2.51	2.29	(156)
CH ₂ (OH)CO ₂ C ₂ H ₅	7.04	17.3	39.2	2.45	2.26	
CH ₃ CH ₂ CO ₂ C ₂ H ₅	7.16	17.9	40.6	2.50	2.26	
CH ₃ CH(OH)CO ₂ C ₂ H ₅	7.32	17.8	39.6	2.43	2.22	
CH ₂ (OH)CH(OH)- CO ₂ C ₂ H ₅	1.85	4.39	10.1	2.43	2.20	
CH ₃ CH(OC ₂ H ₅)CO ₂ C ₂ H ₅	1.97	4.95	11.1	2.51	2.24	
CH ₂ (OC ₂ H ₅)CH ₂ CO ₂ C ₂ H ₅	1.43	3.52	8.47	2.45	2.41	
CH ₃ CH ₂ CH ₂ CO ₂ C ₂ H ₅	5.21	11.0	23.7	2.09	2.17	(144)
(CH ₃) ₂ CHCO ₂ C ₂ H ₅	3.99	9.14	20.3	2.31	2.23	
CH ₃ CH ₂ CH(OH)CO ₂ C ₂ H ₅	3.98	8.70	19.5	2.18	2.24	
(CH ₃) ₂ C(OH)CO ₂ C ₂ H ₅	2.10	5.12	11.2	2.43	2.19	
CH ₃ CH(OH)CH ₂ CO ₂ C ₂ H ₅	1.07	2.76	6.4	2.57	2.33	
(CH ₃) ₂ CHCH ₂ CO ₂ C ₂ H ₅			10.6			(151)
(C ₂ H ₅) ₂ CHCO ₂ C ₂ H ₅			5.73			
CH ₃ CH(CN)CO ₂ C ₂ H ₅	0.914	2.27	4.54	2.48	2.00	
CH ₂ (CN)CH ₂ CO ₂ C ₂ H ₅	1.30	3.34	7.42	2.57	2.24	
CH ₃ CH ₂ CH(CN)CO ₂ C ₂ H ₅	0.615	1.41	3.50	2.29	2.48	
CH ₃ CH(CN)CH ₂ CO ₂ C ₂ H ₅		2.04	4.78		2.34	
CH ₃ CH ₂ CH ₂ CH(CN)- CO ₂ C ₂ H ₅	0.467	1.39	3.10	2.97	2.23	
(CH ₃) ₂ CHCH(CN)- CO ₂ C ₂ H ₅	0.250	0.649	1.81	2.59	2.78	
(C ₂ H ₅) ₂ C(CN)CO ₂ C ₂ H ₅	0.258	0.650	1.44	2.53	2.15	
CH ₃ CH ₂ CO ₂ C ₂ H ₅	7.12	17.71	40.53	2.49	2.29	(152)
CH ₃ CH(OH)CO ₂ C ₂ H ₅	7.61	17.75	39.66	2.33	2.23	
CH ₂ (OH)CH ₂ CO ₂ C ₂ H ₅	1.62	4.06	9.87	2.50	2.43	
CH ₃ CO ₂ CH ₂ CH ₃	6.475	16.2	37.7	2.5	2.3	(154)
CH ₃ CO ₂ CH ₂ CH ₂ (OH).....	4.715	11.73	27.9	2.5	2.4	
CH ₃ CO ₂ CH ₂ CH ₂ (OCH ₃).....		12.25	28.15		2.3	
CH ₃ CO ₂ CH ₂ CH ₂ (OC ₂ H ₅).....	4.65	11.76	27.95	2.5	2.4	
CH ₃ CO ₂ CH ₂ CH ₂ Cl.....	4.68	11.76	27.5	2.5	2.3	
CH ₃ CO ₂ CH ₂ CH ₂ Br.....	5.58	13.46	29.8	2.4	2.3	

Esters in which halogen has been substituted on the α -carbon of the alkyl group saponify with great rapidity.

Influence of Temperature upon Alkaline Saponification of Esters;
Titrimetric Method

Ester	k_a		Q_{10}	Lit.
	0°	25°		
CH ₃ CO ₂ C ₂ H ₅	1.17	6.56	1.99	(143)
CH ₂ (OH)CO ₂ C ₂ H ₅	12.9	65.3	1.91	
CH ₂ (OCH ₃)CO ₂ C ₂ H ₅	36.4	128.0	1.65	
CH ₂ (OC ₂ H ₅)CO ₂ C ₂ H ₅	15.9	64.8	1.75	
CH ₃ (OC ₃ H ₇)CO ₂ C ₂ H ₅	12.7	52.1	1.76	

Influence of Temperature.—(Continued)

Ester	k_a		Q_{10}	Lit.
	0°	25°		
CH ₃ CH ₂ CO ₂ C ₂ H ₅	1.14	5.94	1.94	(143)
CH ₃ CH(OH)CO ₂ C ₂ H ₅	14.6	63.7	1.80	
CH ₂ (OH)CH ₂ CO ₂ C ₂ H ₅	1.83	10.2	1.99	(152)
CH ₂ (OH)CH(OH)CO ₂ C ₂ H ₅	9.02	57.3	2.10	(143)
CH ₃ CH(OC ₂ H ₅)CO ₂ C ₂ H ₅	2.07	9.29	1.82	
CH ₂ (OC ₂ H ₅)CH ₂ CO ₂ C ₂ H ₅	1.07	5.02	1.86	

Influence of Constitution of Ester on Velocity of Hydrolysis;
Titrimetric Method (391); cf. (390)

Ester	k_a				
	0.2°	10°	20°	30°	40°
CH ₃ CO ₂ CH ₂ CH ₃			5.08		
CH ₃ CO ₂ CH ₂ CH ₂ CH ₃	1.03	2.15	4.23	8.10	14.95
CH ₃ CO ₂ CH(CH ₃) ₂	0.319	0.640	1.26	2.50	4.80
CH ₃ CO ₂ CH ₂ CH ₂ CH ₂ CH ₃	0.945	1.94	3.93	7.58	
CH ₃ CO ₂ CH ₂ CH(CH ₃) ₂	0.838	1.76	3.54	6.75	12.9
CH ₃ CO ₂ CH(CH ₃)(C ₂ H ₅).....	0.209	0.419	0.817	1.55	
CH ₃ CO ₂ C(CH ₃) ₃	0.0160	0.0369	0.0810	0.166	
CH ₃ CO ₂ CH ₂ CH ₂ CH- (CH ₃) ₂	0.914	1.80	3.61	6.72	
CH ₃ CO ₂ C(CH ₃) ₂ - (CH ₂ CH ₂ CH ₃).....		0.0175	0.0348	0.0662	
CH ₃ CO ₂ CH ₂ CH:CH ₂		4.29	9.08	17.05	
CH ₃ CO ₂ CH ₂ CH ₂ CH ₂ OH.....		3.32	6.94	13.8	
CH ₃ CO ₂ CH ₂ C ₆ H ₅		4.58	9.90	19.4	
CH ₂ (OH)CO ₂ CH ₂ CH ₂ - CH ₃	11.1	22.8	44.7		
CH ₂ (OH)CO ₂ CH(CH ₃) ₂	3.54	6.96	13.7		

k_a as function of temperature:

$$\log_{10} k_a = -\frac{A'}{T} + B'T + C'$$

Ester	A'	B'	C'
CH ₃ CO ₂ C ₂ H ₅	1780	0.00754	4.53
CH ₃ CO ₂ CH ₂ CH ₂ CH ₃	2359.9	0.001528	8.2351
CH ₃ CO ₂ CH(CH ₃) ₂	883.8	0.019259	-2.5231
CH ₃ CO ₂ CH ₂ CH ₂ CH ₂ CH ₃	1948.9	0.006839	5.2397
CH ₃ CO ₂ CH(CH ₃)(C ₂ H ₅).....	1856.0	0.007903	4.5675
CH ₃ CO ₂ CH(CH ₃)(C ₂ H ₅).....	1820.9	0.007179	4.0242
CH ₃ CO ₂ C(CH ₃) ₃	3300.7	-0.005920	11.9064
CH ₃ CO ₂ CH ₂ CH ₂ CH(CH ₃) ₂	1852.2	0.006817	4.8761
CH ₃ CO ₂ C(CH ₃) ₂ - (CH ₂ CH ₂ CH ₃).....	2419.5	0.000675	6.6014
CH ₃ CO ₂ CH ₂ CH:CH ₂	4954.5	-0.027188	25.8337
CH ₃ CO ₂ CH ₂ CH ₂ CH ₂ (OH).....	2528.8	0.001515	9.0281
CH ₃ CO ₂ CH ₂ C ₆ H ₅	5352.8	-0.031077	28.3700
CH ₂ (OH)CO ₂ CH ₂ CH ₂ CH ₃	2377.6	0.000754	9.5439
CH ₂ (OH)CO ₂ CH(CH ₃) ₂	303.5	0.025939	-5.4259

Ester	k_a	0.2°	10°	20°	30°	40°
CH ₃ CO ₂ (CH ₂) ₂ CH ₃	calc.	1.03	2.13	4.25	8.12	14.92
	obs.	1.03	2.15	4.23	8.10	14.95
CH ₃ CO ₂ CH(CH ₃) ₂	calc.	0.319	0.637	1.27	2.49	4.80
	obs.	0.319	0.640	1.26	2.50	4.80
CH ₃ CO ₂ (CH ₂) ₃ CH ₃	calc.	0.944	1.94	3.91	7.59	
	obs.	0.945	1.94	3.93	7.58	
CH ₃ CO ₂ CH ₂ CH(CH ₃) ₂	calc.	0.844	1.75	3.54	6.87	12.9
	obs.	0.838	1.76	3.54	6.75	12.9
CH ₃ CO ₂ CH(CH ₃)(C ₂ H ₅).....	calc.	0.209	0.419	0.819	1.55	
	obs.	0.209	0.419	0.817	1.55	

Influence of Constitution.—(Continued)

Ester	k_a	0.2°	10°	20°	30°	40°
$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)_3$	calc. 0.0160	0.0370	0.0807	0.166		
	obs. 0.0160	0.0369	0.0810	0.166		
$\text{CH}_3\text{CO}_2(\text{CH}_2)_2\text{CH}(\text{CH}_3)_2$	calc. 0.910	1.82	3.57	6.74		
	obs. 0.914	1.80	3.61	6.72		

k_a of Acid Saponification for Different Mono-esters at 25°C;
Titrimetric Method

Ester	k_a
HCO_2CH_3	0.145 (397.2)
$\text{HCO}_2\text{CH}_2\text{CH}_3$	0.187 (397.2); 0.1845 (353); 0.192 (476)
$\text{HCO}_2\text{CH}_2\text{CH}_2\text{CH}_3$	0.195 (397.2)
$\text{HCO}_2\text{CH}(\text{CH}_3)_2$	0.168 (397.2)
$\text{HCO}_2(\text{CH}_2)_3\text{CH}_3$	0.187 (397.2)
$\text{HCO}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$	0.190 (397.2)
$\text{CH}_3\text{CO}_2\text{CH}_3$	0.00680 (397.2); 0.00659 (245)
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3$	0.00658 (397.2); 0.00658 (391); 0.00682 (245)
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_2\text{CH}_3$	0.00680 (397.2); 0.00671 (245)
$\text{CH}_3\text{CO}_2\text{CH}(\text{CH}_3)_2$	0.00370 (397.2); 0.00360 (391); 0.00350 (467)
$\text{CH}_3\text{CO}_2(\text{CH}_2)_3\text{CH}_3$	0.00660 (397.2)
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$	0.00552 (148)
$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)_3$	0.00740 (391); 0.00758 (467)
$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)_2(\text{CH}_2\text{CH}_2\text{CH}_3)$..	0.0283 (391)
$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)(\text{C}_2\text{H}_5)_2$	0.0731 (391)
$\text{CH}_3\text{CO}_2\text{C}_6\text{H}_5$	0.00469 (467); 0.0046 (492)
$\text{CH}_3\text{CO}_2\text{CH}_2\text{C}_6\text{H}_5$	0.00654 (467); 0.0051 (492)
$\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_3$	0.00724 (397.2); 0.00708 (245)
$\text{CH}_3\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	0.00706 (397.2); 0.00727 (245); 0.00716 (144)
$\text{CH}_3\text{CH}_2\text{CO}_2(\text{CH}_2)_2\text{CH}_3$	0.00724 (245)
$\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{CH}_3$	0.00444 (397.2); 0.00394 (245)
$\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{C}_2\text{H}_5$	0.00417 (245); 0.00460 (148); 0.00521 (144)
$(\text{CH}_3)_2\text{CHCO}_2\text{CH}_3$	0.00398 (397.2)
$(\text{CH}_3)_2\text{CHCO}_2\text{C}_2\text{H}_5$	0.00344 (397.2); 0.00409 (245); 0.00460 (148)
$\text{CH}_3(\text{CH}_2)_3\text{CO}_2\text{C}_2\text{H}_5$	0.00143 (245)
$(\text{CH}_3)_2\text{CHCH}_2\text{CO}_2\text{C}_2\text{H}_5$	0.00207 (148)
$(\text{CH}_3)_3\text{CCO}_2\text{C}_2\text{H}_5$	0.00292 (391)
$\text{CH}_2\text{BrCO}_2\text{C}_2\text{H}_5$	0.00492 (157)
$\text{CO}(\text{NH}_2)\text{CO}_2\text{CH}_3$	0.0020 (473)
$\text{CO}(\text{NH}_2)\text{CO}_2\text{C}_2\text{H}_5$	0.0015 (473)
$\text{CH}_3\text{COCO}_2\text{C}_2\text{H}_5$	0.00722 (397.2); 0.00816 (474)
$\text{CH}_3\text{COCH}_2\text{CO}_2\text{C}_2\text{H}_5$	0.000989 (484)
$\text{CH}_3\text{CO}(\text{CH}_2)_2\text{CO}_2\text{C}_2\text{H}_5$	0.00151 (397.2); 0.00156 (474)
$\text{CH}_3\text{CO}_2\text{CH}_2\text{COCH}_3$	0.00201 (397.2)
$\text{CH}_3\text{CO}_2(\text{CH}_2)_3\text{COCH}_3$	0.00595 (397.2)
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CO}_2\text{H}$	0.0018 (265, 266)
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CO}_2^-$	0.0060 (265, 266)

Values of k_a (397.2)

Alcohol	Formate	Acetate	Propi- onate	<i>n</i> -Buty- rate
$\text{CH}_3\text{OCH}_2\text{OH}$		0.143	0.0925	
$\text{CH}_3\text{CH}_2\text{OCH}_2\text{OH}$		0.520	0.325	
$\text{CH}_3(\text{CH}_2)_2\text{OCH}_2\text{OH}$		0.510	0.319	
$\text{HO}(\text{CH}_2)_2\text{OH}$	0.121	0.00485		
$\text{CH}_3\text{O}(\text{CH}_2)_2\text{OH}$	0.121	0.00483	0.00503	0.00315
$\text{CH}_3\text{CH}_2\text{O}(\text{CH}_2)_2\text{OH}$	0.124	0.00476		0.00276
$\text{CH}_3(\text{CH}_2)_2\text{O}(\text{CH}_2)_2\text{OH}$	0.122			
$\text{HO}(\text{CH}_2)_3\text{OH}$	0.153	0.00599		

Values of k_a (397.2).—(Continued)

Alcohol	Formate	Acetate	Propi- onate	<i>n</i> -Buty- rate
$\text{CH}_3\text{O}(\text{CH}_2)_3\text{OH}$	0.151	0.00574		
$\text{CH}_3\text{CH}_2\text{O}(\text{CH}_2)_3\text{OH}$	0.158	0.00579		
$\text{CH}_3(\text{CH}_2)_2\text{O}(\text{CH}_2)_3\text{OH}$	0.156			

Acid	CH_3 -ester	C_2H_5 -ester
$\text{CH}_2(\text{OH})\text{CO}_2\text{H}$		0.00716
$\text{CH}_2(\text{OCH}_3)\text{CO}_2\text{H}$	0.00373	0.00393
$\text{CH}_2(\text{OC}_2\text{H}_5)\text{CO}_2\text{H}$	0.00367	0.00361
$\text{CH}_2[\text{O}(\text{CH}_2)_2\text{CH}_3]\text{CO}_2\text{H}$	0.00357	0.00357
$\text{CH}_2[\text{O}(\text{CH}_2)_3\text{CH}_3]\text{CO}_2\text{H}$	0.00334	
$\text{CH}_2[\text{OCH}_2\text{CH}(\text{CH}_3)_2]\text{CO}_2\text{H}$	0.00317	
$\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$	0.00780	0.00766
$\text{CH}_3\text{CH}(\text{OC}_2\text{H}_5)\text{CO}_2\text{H}$	0.00239	
$\text{CH}_3\text{CH}(\text{OC}_2\text{H}_5)\text{CO}_2\text{H}$		0.00211
$(\text{CH}_3)_2\text{C}(\text{OH})\text{CO}_2\text{H}$		0.00205
$\text{CH}_2(\text{OCH}_3)\text{CH}_2\text{CO}_2\text{H}$	0.00147	
$\text{CH}_2(\text{OC}_2\text{H}_5)\text{CH}_2\text{CO}_2\text{H}$		0.00133
$\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CO}_2\text{H}$		0.00114
$\text{CH}_2(\text{OH})\text{CH}(\text{OH})\text{CO}_2\text{H}$	0.00181	
$\text{CH}_2(\text{OCH}_3)\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$	0.00339	
$\text{CH}_2(\text{OC}_2\text{H}_5)\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$	0.00324	
$\text{CH}_2(\text{OCH}_3)\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$	0.00392	

 k_a of Acid Saponification of Mono-esters at 40°C

Ester	k_a
$\text{HCO}_2\text{C}_2\text{H}_5$	0.51 (345)
$\text{HCO}_2\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$	0.479 (99)
$\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$	0.0197 (157); 0.0259 (99)
$\text{CH}_3\text{CO}_2(\text{CH}_2)_2\text{CH}_3$	0.0201 (157)
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}:\text{CH}_2$	0.0214 (99)
$\text{CH}_2\text{ClCO}_2\text{C}_2\text{H}_5$	0.0152 (345)
$\text{CH}_2\text{ClCO}_2(\text{CH}_2)_2\text{CH}_3$	0.0119 (157)
$\text{CH}_2\text{ClCO}_2\text{CH}_3$	0.0166 (345)
$\text{CH}_2\text{BrCO}_2(\text{CH}_2)_2\text{CH}_3$	0.0153 (157)
$\text{CH}_3\text{CO}_2\text{C}_6\text{H}_5$	0.0152 (345)
$\text{CHCl}_2\text{CO}_2\text{C}_2\text{H}_5$	0.0244 (345)
$\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_3$	0.0283 (99)
$\text{CH}_3\text{CHClCO}_2\text{CH}_3$	0.0101 (99)
$\text{CH}_3\text{CCl}_2\text{CO}_2\text{CH}_3$	0.0243 (99)
$\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{CH}_3$	0.0160 (99)
$\text{CH}_3\text{CH}:\text{CHCO}_2\text{CH}_3$, Methyl croton- ate.....	0.00102 (99)
$\text{CH}_3\text{CH}:\text{CHCO}_2\text{CH}_3$, Methylisocro- tonate.....	0.00453 (99)
$\text{C}_6\text{H}_5\text{CO}_2\text{CH}_3$	0.00014 (345)

 k_a of Alkaline Saponification of Mono-esters at 0°C (144);
Conductivity Method

Ester	k_a
$\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$	1.2
$\text{CH}_3\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	1.1
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	0.68
$(\text{CH}_3)_2\text{CHCO}_2\text{C}_2\text{H}_5$	0.46
$\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CO}_2\text{C}_2\text{H}_5$	6.2
$\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	2.1
$(\text{CH}_3)_2\text{C}(\text{OH})\text{CO}_2\text{C}_2\text{H}_5$	1.6

 k_a of Alkaline Saponification of Mono-esters at 25°C

Ester	k_a	Method	Lit.
$\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$	6.5	(a)	(177, 178, 531)
$\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$	6.2	(b)	(536.5)
$\text{CH}_3\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	5.3	(a)	(177, 178, 531)
$\text{CH}_2(\text{OH})\text{CO}_2\text{C}_2\text{H}_5$	75		

k_a of Alkaline Saponification of Mono-esters at 25°C.—(Continued)

Ester	k_a	Method	Lit.
$\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{C}_2\text{H}_5$	63.5	(a)	(177, 178, 531)
$\text{C}_6\text{H}_5\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	12.4		
$\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{CO}_2\text{CH}_3$	157		
$\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{CO}_2\text{C}_2\text{H}_5$	66		
$\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{CO}_2\text{CH}_2\text{CH}_2\text{CH}_3$	55		
$\text{C}_6\text{H}_5\text{CH}_2\text{CH}(\text{OH})\text{CO}_2\text{C}_2\text{H}_5$	40.1		
$\text{C}_6\text{H}_5\text{CH}(\text{OCH}_3)\text{CO}_2\text{C}_2\text{H}_5$	23.3		
$\text{C}_6\text{H}_5\text{CH}(\text{OC}_2\text{H}_5)\text{CO}_2\text{C}_2\text{H}_5$	15.7		
$\text{C}_6\text{H}_5\text{CH}(\text{OCH}_2\text{CH}_2\text{CH}_3)\text{CO}_2\text{C}_2\text{H}_5$	13.3		
$\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	16.5		
$\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	4.9		
$\text{C}_6\text{H}_5\text{CH}_2\text{CO}_2\text{CH}_3$	27.4		
$\text{CO}(\text{NH}_2)\text{CO}_2\text{CH}_3$	48 000	(c)	(473)
$\text{CO}(\text{NH}_2)\text{CO}_2\text{C}_2\text{H}_5$	22 000		
$\text{CH}_3\text{COCO}_2\text{C}_2\text{H}_5$	110 000	(c)	(474)
$\text{CH}_3\text{COCH}_2\text{CO}_2\text{C}_2\text{H}_5$	28.6	(d)	(218)
$\text{CH}_3\text{COCH}_2\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	7.7	(c)	(474)
$\text{CH}_3\text{CO}_2\text{CH}(\text{CH}_3)_2$	1.57	(d)	(467)
$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)_3$	0.090		
$\text{CH}_3\text{CO}_2\text{C}_6\text{H}_5$	82.0		
$\text{CH}_3\text{CO}_2\text{CH}_2\text{C}_6\text{H}_5$	11.8		
$\text{CH}_2(\text{OCOCH}_3)\text{CO}_2^-$	3.3	(d)	(218)
$1\text{-CO}_2^-(\text{CHOCOCH}_3)\text{CH}_2\text{CO}_2^-$	0.23		

Methods: (a) = conductivity; (b) refractometer; (c) buffer salts; (d) titrimetric.

 k_a of Alkaline Saponification of Mono-esters at 20°C; Titrimetric Method

Ester	k_a	Lit.
$\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$	5.08	(391)
$\text{CH}_3\text{CO}_2\text{CH}(\text{C}_2\text{H}_5)_2$	0.340	
$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)_2(\text{C}_2\text{H}_5)$	0.0372	
$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)(\text{C}_2\text{H}_5)_2$	0.0172	
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}:\text{CH}_2$	9.08	
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_2\text{CH}:\text{CH}_2$	5.73	
$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)_2(\text{CH}_2\text{CH}:\text{CH}_2)$	0.0600	
$\text{CH}_3\text{CO}_2\text{CH}(\text{CH}_3)(\text{C}_6\text{H}_5)$	3.37	
$\text{CH}_3\text{CO}_2\text{CH}(\text{C}_2\text{H}_5)(\text{C}_6\text{H}_5)$	2.06	
$(\text{CH}_3)_3\text{CCO}_2\text{C}_2\text{H}_5$	1.18	
$\text{CH}_2(\text{OH})\text{CO}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$	37.2	
$\text{CH}_2(\text{OH})\text{CO}_2\text{CH}(\text{CH}_3)(\text{C}_2\text{H}_5)$	9.25	
$\text{CH}_3\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	5.44	(553)
$\text{CH}_2:\text{CHCO}_2\text{C}_2\text{H}_5$	5.78	
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$	3.213	
$\text{CH}_3\text{CH}:\text{CHCO}_2\text{C}_2\text{H}_5$	0.842	

 k_a of Alkaline Saponification of Mono-esters at 15°C; Titrimetric Method (397.5)

Acid	$\text{CH}_3\text{-ester}$	$\text{C}_2\text{H}_5\text{-ester}$	$n\text{-C}_3\text{H}_7\text{-ester}$
	k_a		
$\text{CH}_2(\text{OH})\text{CO}_2\text{H}$		29.0	
$\text{CH}_2(\text{OCH}_3)\text{CO}_2\text{H}$	55	33.8	27.2
$\text{CH}_2(\text{OCH}_2\text{CH}_3)\text{CO}_2\text{H}$	50.5	26.2	
$\text{CH}_2(\text{OCH}_2\text{CH}_2\text{CH}_3)\text{CO}_2\text{H}$	52.3	31.2	21.5
$\text{CH}_2(\text{OCH}_2\text{CH}_2\text{CH}_2\text{CH}_3)\text{CO}_2\text{H}$	51.7		
$\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$	39.6	26.1	
$\text{CH}_3\text{CH}(\text{OCH}_3)\text{CO}_2\text{H}$	16.8		
$\text{CH}_3\text{CH}(\text{OC}_2\text{H}_5)\text{CO}_2\text{H}$		5.20	
$\text{CH}_2(\text{OCH}_3)\text{CH}_2\text{CO}_2\text{H}$	5.05		

 k_a of Alkaline Saponification of Mono-esters at 15°C; Titrimetric Method (397.5).—(Continued)

Acid	CH ₃ - ester	C ₂ H ₅ - ester	n-C ₃ H ₇ - ester
	<i>k_a</i>		
CH ₂ (OC ₂ H ₅)CH ₂ CO ₂ H.....		2.40	
CH ₂ (OCH ₃)CH ₂ CH ₂ CO ₂ H.....	4.61		
CH ₂ (OC ₂ H ₅)CH ₂ CH ₂ CO ₂ H.....	4.40		
CH ₂ (OCH ₃)CH ₂ CH ₂ CH ₂ CO ₂ H....	3.85		

Alcohol	<i>k_a</i> for:			
	Acetate	Propi- onate	n-Buty- rate	Iso- butyrate
CH ₃ OCH ₂ OH.....	15.55	14.1		
CH ₃ CH ₂ OCH ₂ OH.....	13.1	11.9		
CH ₃ CH ₂ CH ₂ OCH ₂ OH....	11.1	11.3		
HOCH ₂ CH ₂ OH.....	7.17			
CH ₃ OCH ₂ CH ₂ OH.....	6.20	5.30	3.41	3.11
CH ₃ CH ₂ OCH ₂ CH ₂ OH....	5.82	5.00	2.98	2.49
CH ₃ CH ₂ CH ₂ OCH ₂ CH ₂ OH	5.54	4.90	2.99	2.48
HO(CH ₂) ₃ OH.....	4.17			
CH ₃ O(CH ₂) ₃ OH.....	3.51			
CH ₃ CH ₂ O(CH ₂) ₃ OH.....	3.33			

 k_a of Alkaline Saponification of Esters of Formic Acid; cf. (383, 531, 451)

Ester	°C	k_a	°C	k_a	Method	Lit.
HCO_2CH_3	18	1452			(a)	(165)
	18	1656			(b)	
	0	460	25	2400	(c)	(481)
$\text{HCO}_2\text{C}_2\text{H}_5$	0	330	25	1400	(c)	
			25	1080	(d)	(476)

Methods: (a) = residual current; (b) = conductivity; (c) = kinetic buffers; (d) = buffer salts.

The Three Saponification Constants for Ethyl and Vinyl Acetates at 25°C; Titrimetric Method (294, 485)

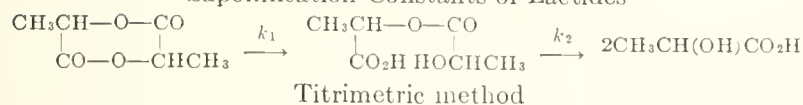
Ester	k_w	k_s	k_a
$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3$	0.0000000092	0.00546	9.83
$\text{CH}_3\text{CO}_2\text{CH}:\text{CH}_2$	0.0000068	0.00813	620

The Saponification Constants of Lactones at 25°C; Titrimetric Method

Lactone	k_w	k_s	k_a	
$\text{CH}_3\text{CHCH}_2\text{COO}$	0.0009		50	(281)
$\text{CH}_2\text{CH}_2\text{COO}$	0.0035		119	
$\text{CH}_2\text{CH}(\text{CH}_3)\text{COO}$	0.0039		140	
$d\text{-OCOCH}_2\text{CHCO}_2\text{H}$	0.00035	0.00096		(268)
$\text{CH}_2\text{CH}_2\text{CH}_2\text{COO}$		0.0138		(291)
$\text{CH}_3\text{CHCH}_2\text{CH}_2\text{COO}$		0.0106	24.7	(246, 265, 291)
$d\text{-OCO}(\text{CHOH})_2\text{CH-}$				
CHOHCO_2H		0.00394		(361)
$\text{COCH}_2\text{CHCO}_2\text{H}$		0.00883	43	(268)
O-CH_2				

As a rule, with β -lactones, k_w is large as compared with $[\text{H}^+]k_s$, with γ - and δ -lactones, it is small. With lactic acid (d -malolactic acid, d -saccharic acid- γ -lactone, paraconic acid) k_a applies for the anion and k_s chiefly for the undissociated lactone acid.

Saponification Constants of Lactides



Ester	°C	k_w	k_s	k_a	Lit.
Glycolide, k_1	19.8	0.0179	0.119		(283)
Lactide, k_1	19.8	0.00313	0.0611		
Lactide, k_1	25	0.00459	0.1088	1.2×10^6	(423)
Lactide, k_2	25		0.00203	19.5	

Saponification of Symmetrical Esters of Dicarboxylic Acids at 25°C

The constant of alkaline saponification holds for the anion; that of acid saponification for the undissociated ester acid.

Buffer-salts method (450, 451, 465, 468, 471, 474.5, 479, 480)

Ester	Stage*	k_s	k_a
Dimethyl oxalate.....	k_1	0.0192	1 760 000
	k_2	0.0096	90
Diethyl oxalate.....	k_1	0.0106	530 000
	k_2	0.0053	36
Dimethyl malonate.....	k_1	0.00206	147
	k_2	0.00103	2.0
Diethyl malonate.....	k_1	0.00206	59
	k_2	0.00103	0.88
Dimethyl succinate.....	k_1		26
	k_2		2.8
Dimethyl glutarate.....	k_1		21.6†
	k_2		3.16†
Diethyl glutarate.....	k_1		10.0†
	k_2		1.63†
Dimethyl suberate.....	k_1		1.53†
	k_2		0.49†
Dimethyl azelate.....	k_1		1.24†
	k_2		0.42†
Dimethyl sebacate.....	k_1		1.2†
	k_2		0.43†
Dimethyl tartrate‡.....	k_1		363
	k_2		18
Dimethyl antitartrate.....	k_1		258
	k_2		9
Dimethyl fumarate.....	k_1		414
	k_2		19
Dimethyl maleate.....	k_1		48
	k_2		0.72

* Saponification stage.

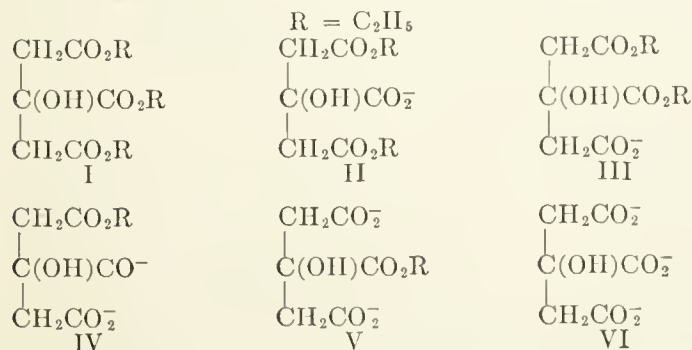
† These constants were measured in 50 vol. % aqueous alcohol; methyl alcohol for the methyl esters and ethyl alcohol for the ethyl esters.

‡ The saponification constants for *d*-, *l*-, and *dl*-tartaric esters are the same.

For diethyl diethylmalonate ($\text{C}_2\text{H}_5)_2\text{C}(\text{CO}_2\text{C}_2\text{H}_5)_2$, the two constants of alkaline saponification at 85°C in 50 vol. % aqueous alcohol are 0.138 and 0.0122 (157.5).

Alkaline Saponification of Esters of Polycarboxylic Acids with Unlike Groups

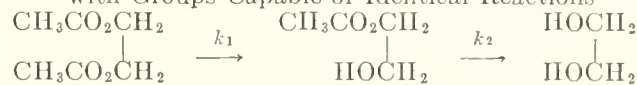
Ethyl citrate in aqueous solution; titrimetric method (405)



Ethyl citrate.—(Continued)

Reaction	k_a		
	15°	23°	30°
I \rightarrow III.....	63.7	98.9	149.8
III \rightarrow V.....	2.92	4.28	5.14
II \rightarrow IV.....	0.841	1.48	2.27
V \rightarrow VI.....	0.0149	0.0283	0.0409
IV \rightarrow VI.....	0.132	0.238	0.302

Saponification, in Aqueous Solution, of Esters of Poly-alcohols with Groups Capable of Identical Reactions



k is the constant calculated on the equivalent basis. For $k_1/k_2 = 2/1$, $k = 0.5k_1 = k_2 = \text{constant}$ or more generally: if the velocity is directly proportional to the number of reacting groups in the molecule, k is constant.

Titrimetric method

Ester	k_s	°C	Lit.	k_a	°C	Lit.
$(\text{CH}_3\text{CO}_2\text{CH}_2)_2$				2.50	0	(313)
				12.54	19.8	
	0.00235	18	(363)	7.618	18	(364)
	0.00456	25.2		16.330	25	
$(\text{CH}_3\text{CO}_2\text{CH}_2)_4\text{C}$...	0.00432	25	(487)	20.5	25	(487)

The constants k_s (resp. k_a) calculated from equivalents are approximately constant.

Saponification of Esters of Poly-alcohols with Unlike Groups (*e.g.*, Glycerol) in Aqueous Solution

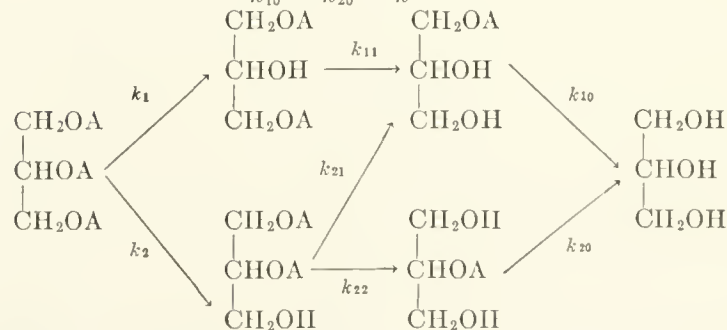
Titrimetric method; k = the "equivalent constant" for saponification of glyceryl acetate

	Monacetin	Diacetin	Triacetin	°C	Lit.
10^3k_s	2.27	1.93	2.00	18	(360)
10^3k_s	4.32	3.53	3.62	25.2	
10^3k_s			8.94	35	(562)
k_a	8.13	7.85	7.89	18	(364)
k_a	17.22	17.79	16.74	25	
k_a	20.1–21.5	22.1–25.5	21.9–22.5	25	(491)

For further data on saponification of glyceryl esters, see (1, 196, 337, 508, 520).

The conditions for $k = \text{constant}$ are (543):

$$\begin{aligned} k_1 + k_2 &= 3k \\ k_{11} = k_{21} + k_{22} &= 2k \\ k_{10} = k_{20} &= k \end{aligned}$$



where A = Acyl.

For the effect of rearrangement (acyl wandering) on the variation of k , see (487).

Saponification of Fats by NaOH in 95% Alcohol at 25°C; Titrimetric Method (271)

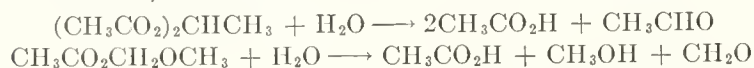
S = Saponification number; A = Acid number; I = Iodine number

Fat	S	A	I	$60k_a$
Almond oil.....	191.0	5.6	95.9	2.2
Lard.....	249.1	16.9	22.1	2.1
Castor oil.....	177.9	4.0	85.5	2.1

Saponification of Fats.—(Continued)

Fat	S	A	I	60k _a
Codliver oil.....	182.4	2.3	156.4	2.3
Rapeseed oil.....	170.6	14.2	104.3	2.1
Linseed oil.....	188.4	7.3	177.7	2.1

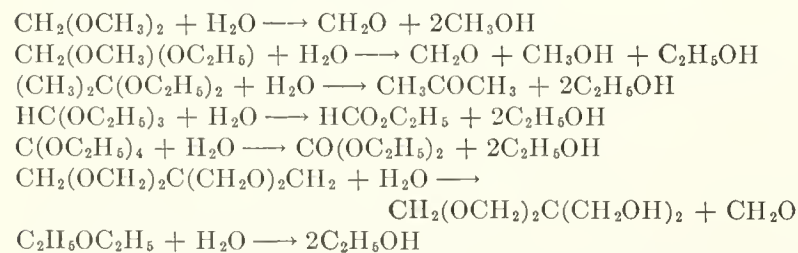
Saponification of a Few Aldehyde Derivatives of Ester Character at 25°C in Aqueous Solution; Titrimetric Method (459, 461, 463, 477, 478)



Ester	Values of <i>k</i> reduced to the basis of one ether-oxygen		
	<i>k_w</i>	<i>k_s</i>	<i>k_a</i>
(CH ₃ CO ₂) ₂ CH ₂		0.00402	476
(CH ₃ CO ₂) ₂ CHCH ₃		0.00302	48
CH ₃ CO ₂ CH ₂ OCH ₃		0.0715	34
CH ₃ CO ₂ CH ₂ OC ₂ H ₅		0.260	29.5
(CH ₃ CO ₂) ₂ CHCH ₃		0.00345	65
(C ₂ H ₅ CO ₂) ₂ CHCH ₃		0.00453	47
(CH ₃ CO ₂)(C ₂ H ₅ CO ₂)CHCH ₃		0.00403	52.5
CH ₃ CO ₂ CH(CH ₃)(OC ₂ H ₅).....	0.37		
[(CH ₃ CO ₂) ₂ CH] ₂	0.000034	0.00410	685

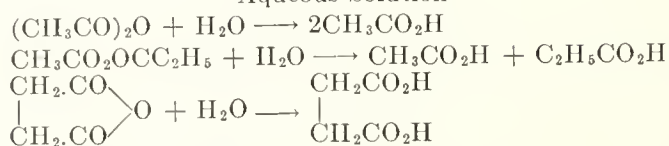
Hydrolysis of Ethers and Ethereal Substances (Alkylacetals, Orthocarboxylic Acid Esters) at 25°C, in Aqueous Solution; Titrimetric Method (457, 458, 460, 461, 462, 470, 476, 478, 487.5)

k_a for ethers is usually immeasurably small.



Ether	Values of <i>k</i> reduced to the basis of one ether-oxygen	
	<i>k_w</i>	<i>k_s</i>
CH ₃ C(OC ₂ H ₅) ₃	0.00019	333 000
HC(OC ₂ H ₅) ₃		23 300
C(OC ₂ H ₅) ₄	0.000085	3 000
(CH ₃) ₂ C(OCH ₃) ₂		18 500
(CH ₃) ₂ C(OC ₂ H ₅) ₂		67 500
CH ₃ CH(OC ₂ H ₅) ₂		30
CH ₂ (OCH ₃) ₂		0.03765
CH ₂ (OC ₂ H ₅) ₂		0.00468
CH ₂ (OCH ₃)(OC ₂ H ₅).....		0.00272
C ₂ H ₅ OC ₂ H ₅		0.066*
CH ₂ (OCH ₃) ₂		0.0376
CH ₂ (OC ₂ H ₅) ₂		0.0065
CH ₂ (OCH ₂ CH ₂ CH ₃) ₂		0.0072
CH ₂ [OCH(CH ₃) ₂] ₂		0.0362
CH ₂ (OCH ₂ CH ₂ CH ₂ CH ₃) ₂		0.00715
CH ₂ [OCH ₂ CH(CH ₃) ₂] ₂		0.00995
CH ₂ [OCH(CH ₃)(C ₂ H ₅)] ₂		0.0496
C[(CH ₂ O) ₂ CH ₂] ₂		0.05
C[(CH ₂ O) ₂ CHCH ₃] ₂		0.003
C[(CH ₂ O) ₂ CHC ₂ H ₅] ₂		0.0051
C[(CH ₂ O) ₂ CHCH(CH ₃) ₂] ₂		0.0022
C[(CH ₂ O) ₂ C(CH ₃) ₂] ₂		5.2

* This value is extrapolated from 9×10^{-5} at 98°C.

The Constant, *k_w*, of Hydration of Organic Acid Anhydrides in Aqueous Solution

The anhydrides undergo a rapid saponification in water. Because of the high value of *k_w*, *k_s* and *k_a* are measured only with difficulty.

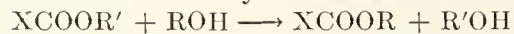
Conductivity method except for those of (454) which were determined from the kinetics of the simultaneous reaction with iodide-iodate.

Acid anhydride	<i>k_w</i> , 0°	Lit.	<i>k_w</i> , 25°	Lit.
Acetic.....	0.0336	(525)	0.170 (525)	
			0.160 (425)	
			0.175 (554)	
			0.190 (454)	
Propionic.....	0.0161	(525)	0.0857 (425, 525)	
Propionic-acetic.....			0.121 (525)	
<i>n</i> -Butyric.....	0.0108	(525)	0.0560 (554)	
			0.0470 (525)	
Isobutyric.....	0.0105	(525)	0.0523 (525)	
Isopropylacetic.....			0.023↓	
Butyric-isopropylacetic....			0.0357	
Methylethylacetic.....			0.041↓	
Succinic.....	0.0202	(56, 527)	0.169 (56, 527)	
			0.159 (425)	
Methylsuccinic.....			0.227	
Ethylsuccinic.....			0.154 (525)	
<i>asym.</i> -Dimethylsuccinic....			0.176	
<i>sym.</i> -Dimethylsuccinic....		M. P. = 87°	0.253 (56)	
		M. P. = 42°	0.352	
Trimethylsuccinic.....			0.180 (525)	
Tetramethylsuccinic.....			0.0147	
Maleic.....	0.287	(56)	1.59 (425)	
Glutaric.....			0.171 (527)	
β-Acetylhydroxyglutaric...	0.0269	(56)	0.221 (56)	
Phthalic.....			0.607 (425)	
Itaconic.....			0.179	
Citraconic.....			1.057	
Benzoic.....			0.0218 (554)	
Camphoric.....			0.0219	

For velocity of reaction in various solvents, its acceleration by acids and the influence of the initial anhydride concentration on *k_w*, see (392).

Alcoholysis of Esters (Interconversion of Ester by Alcohol) in Solutions of ROH

The reaction is accelerated by acids as well as bases:



The velocity is proportional to the HCl concentration; *k* = monomolecular constant referred to [HCl] = 1; *t* in minutes; *θ* = 30°C; polarimetric method (135, 136).

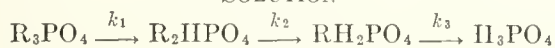
Ester	Solvent	10%
Menthyl butyrate.....	Methyl alcohol	6 200
Menthyl crotonate.....		561
Menthyl hydrocinnamate.....		5 185
Menthyl cinnamate.....		397
Ethyl butyrate.....		90 200
Ethyl crotonate.....		6 250
Ethyl hydrocinnamate.....		78 000
Ethyl cinnamate.....		3 900
Ethyl butyrate.....	Menthol	58
Methyl butyrate.....		94.4
Methyl crotonate.....		9.7

Alcoholysis of Esters.—(Continued)

Ester	Solvent	10 ⁵ k
Methyl butyrate.....	Ethyl alcohol	19 800
Methyl crotonate.....		1 400
Methyl hydrocinnamate.....		19 100
Methyl cinnamate.....		1 075

Saponification of Esters of Inorganic Acids, Including Carbonic and Sulfonic Acids

SAPONIFICATION OF PHOSPHORIC ACID ESTERS IN AQUEOUS SOLUTION



Titrimetric method; first-order reaction; t in hours; water saponification

R	88°C (107)		
	k_1	k_2	k_3
CH ₃	0.0632	0.0036	0.0056
CH ₃ CH ₂	0.0114	0.0015	0.0032
CH ₂ :CHCH ₂		0.0191	0.00533

R	44°C (107)	
CH ₃	$k_3 = 0.000047$	$Q_{10} = 2.96$
C ₂ H ₅	$k_2 = 0.000022$	$Q_{10} = 2.61$
C ₂ H ₅	$k_1 = 0.000115$	$Q_{10} = 2.85$

Values of k_1 at 100°C (153)

Ester	10 ⁴ k ₁
(CH ₃) ₃ PO ₄	1314
(C ₂ H ₅) ₃ PO ₄	322
(CH ₃) ₂ (C ₂ H ₅)PO ₄	1110
(CH ₃) ₂ (CH ₃ CH ₂ CH ₂)PO ₄	1212
(C ₂ H ₅) ₂ (CH ₃ CH ₂ CH ₂)PO ₄	366

Alkaline saponification of phosphoric acid esters; second-order reaction; units: hours and M/l (107)

(C₂H₅)₃PO₄; k_1 , 13° = 0.011; k_1 , 88° = 3.28. k_1 is measurable; k_2 and k_3 are immeasurably slow.

SAPONIFICATION OF CHLORIDES AND NITRATES; WATER SAPONIFICATION NOT APPRECIABLY ACCELERATED BY ACIDS

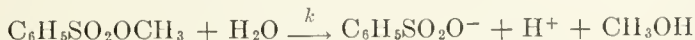
Titrimetric method; first-order k ; t in minutes; solvent, equal volumes of H₂O and 95.4% alcohol (388, 389)

C ₆ H ₅ CH ₂ Cl, 10 ⁴ k.....	1.1(30°)	3.2(40°)	157.0(83°)
C ₆ H ₄ (CH ₃)(CH ₂ Cl).....	<i>o</i> -	<i>m</i> -	<i>p</i> -
10 ³ k at 30°.....	0.55	0.144	1.04
k at 83°.....	0.077	0.0221	0.163
C ₆ H ₄ (Cl)(CH ₂ Cl), k at 83°....	0.0052	0.00368	0.0088
C ₆ H ₄ (NO ₂)(CH ₂ Cl), k at 83°...	0.00130	0.00140	0.00115

1-Monochlorohydrin, CH₂ClCHOHCH₂OH, in aqueous soln.; 10⁵k = 9 at 100°C.

Ethyl nitrate, C₂H₅ONO₂, in equal volumes of H₂O and acetone; 10⁵k = 8.3 at 64°C.

SAPONIFICATION OF SULFONIC ACID ESTERS IN AQUEOUS SOLUTION



Titrimetric method; $k = k_w + [H^+]k_s + [OH^-]k_a$; units: minutes and M/l; $\theta = 25^\circ\text{C}$ (408, 542)

$[H^+]k_s$ even in rather strongly acid solution is vanishingly small in comparison with the constant, k_w , of water saponification.

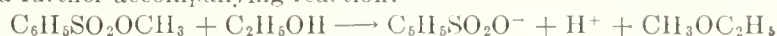
$$k_w = 0.0007015; k_a = 0.05275$$

In the presence of halogen ion, X⁻, the accompanying reaction:
C₆H₅SO₂OCH₃ + X⁻ $\xrightarrow{k_0}$ C₆H₅SO₂O⁻ + CH₃X
also proceeds according to:

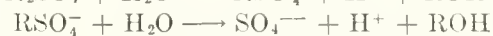
$$\frac{dx}{dt} = k_0[X^-](a - x)$$

X ⁻	Cl ⁻	Br ⁻	I ⁻
k_0 , 25°C.....	0.00139	0.00513	0.0398

In the presence of alcohol, *cf.* (408.5), the following proceeds as a further accompanying reaction:



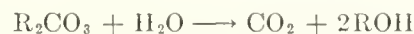
SAPONIFICATION OF SULFURIC ACID ESTERS



The first reaction follows the same law as for the saponification of sulfonic acid esters (301.5).

In aqueous solution at 60°C, with units of M/l and hours, $k_s = 0.00209$ for alkaline saponification according to the second stage of saponification (340.5).

SAPONIFICATION OF CARBONIC ACID ESTERS IN AQUEOUS SOLUTION

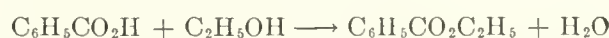


Titrimetric method; units: minutes and M/l; $\theta = 25^\circ\text{C}$ (452, 458); constant for alkaline saponification

R.....	CH ₃	C ₂ H ₅
k_a	7.0	1.6

k_s and k_w are immeasurably small.

Esterification



The velocity of esterification is retarded by water (220, 542.5).

Esterification in Ethyl Alcohol with HCl as Catalyst at 25°C

First-order k for minutes; c = concentration of HCl in M/l; w = concentration of H₂O in M/l; titrimetric method (287, 290, 292, 293).

$$\begin{aligned} \frac{2.303}{60k} &= 5.78 + \frac{13.24}{c} + \left(-35.36 + \frac{59.26}{c} - \frac{4.778}{c^2} + \frac{1.707}{c^3} \right) \\ &\quad (w - 0.013) + \left(16.98 - \frac{24.80}{c} + \frac{38.35}{c^2} - \frac{3.679}{c^3} \right) (w - 0.013)^2 \\ &\quad c = 0.15 - 0.8; w = 0.03 - 2.26 \end{aligned}$$

$$\begin{aligned} \frac{2.303}{60k} &= 6.554 + \frac{4.850}{c} + \frac{0.0985}{c^2} + \left(-40.15 + \frac{35.39}{c} - \frac{0.9550}{c^2} \right) (w - 0.013) \\ &\quad + \left(16.90 + \frac{12.98}{c} - \frac{1.259}{c^2} \right) (w - 0.013)^2 \\ &\quad c = 0.16 - 0.67; w = 0.04 - 1.3 \end{aligned}$$

$$\begin{aligned} \frac{2.303}{60k} &= -3.33 + \frac{49.07}{c} - \frac{2.916}{c^2} + \left(61.1 - \frac{23.40}{c} + \frac{25.02}{c^2} \right) \\ &\quad (w - 0.013) + \left(-276.6 + \frac{260.6}{c} - \frac{10.02}{c^2} \right) (w - 0.013)^2 \\ &\quad c = 0.16 - 0.67; w = 0.04 - 1.3 \end{aligned}$$

For dibasic acids, the first-order k is calculated on the equivalent basis.

$$\begin{aligned} \frac{2.303}{60k} &= 0.0758 + \frac{0.19146}{c} - \frac{0.0053507}{c^2} + \frac{0.000045457}{c^3} + \\ &\quad \left(-1.0875 + \frac{0.73858}{c} + \frac{0.085448}{c^2} - \frac{0.00075172}{c^3} \right) w \\ &\quad + \left(-0.0327 + \frac{0.50665}{c} - \frac{0.028853}{c^2} + \frac{0.00025145}{c^3} \right) w^2 \\ &\quad c = 0.01 - 0.67; w = 0.002 - 1.4 \end{aligned}$$

$$\begin{aligned} \frac{60k}{2.303} &= 0.869 + \frac{1.074}{c} - \frac{0.01946}{c^2} + \left(-4.009 + \frac{2.893}{c} + \frac{0.8231}{c^2} \right) w \\ &\quad + \left(-1.187 + \frac{3.425}{c} + \frac{0.1134}{c^2} \right) w^2 \\ &\quad c = 0.16 - 0.66; w = 0.002 - 1.4 \end{aligned}$$

$$\begin{aligned} \frac{2.303}{60k} &= 0.446 + \frac{0.4999}{c} - \frac{0.006107}{c^2} + \left(-1.598 + \frac{1.292}{c} + \frac{0.3286}{c^2} \right) w \\ &\quad + \left(-2.069 + \frac{2.818}{c} - \frac{0.09158}{c^2} \right) w^2 \\ &\quad c = 0.16 - 0.67; w = 0.002 - 1.4 \end{aligned}$$

Esterification in Glycerol with HCl as Catalyst at 25°C

Benzoic acid

$$\frac{2.303c}{60k} = 21.74 + 140.2w - 65.32w^{3/2}$$

$$c = 0.08 - 0.24; w = 0.03 - 2.0$$

n-Butyric acid

$$\frac{2.303c}{60k} = 0.6072 + 0.5811w + 0.07628w^{3/2}$$

$$c = 0.04 - 0.2; w = 0.03 - 1.35$$

Esterification in Ethyl Alcohol at 25°C without Catalyst

a = concentration of acid (in equivalents).

$$k_2 = \frac{1}{ta} \times \frac{x}{(a-x)}; \text{bimolecular constant}$$

$$k_2 = \frac{2}{t} \left(\frac{1}{\sqrt{a-x}} - \frac{1}{\sqrt{a}} \right); \text{sesquimolecular constant}$$

Acid	$10^5 k_2$	$10^5 k_3$	<i>a</i>	<i>w</i>
Mandelic.....	0.8		0.4 - 0.7	0.03 - 0.1
Trichloroacetic.....	11.0		0.14 - 0.57	0.1 - 0.2
Malic.....		0.30	0.14 - 0.4	0.05
Succinic.....		0.18	0.1 - 0.4	0.05
Tartaric.....		0.43	0.1 - 0.4	0.02
		0.17	0.1 - 0.4	1.40

For the esterification of HCl by C_2H_5OH , see (288, 289, 296).THE CATALYTIC ESTERIFICATION OF VARIOUS ORGANIC ACIDS IN CH_3OH Titrimetric method; *t* in hours; k_s = monomolecular constant referred to $[HCl] = 1$ (503, 504, 504.5)

Acid	k_s , 15°	k_s , 20°
Formic, HCO_2H	2568	
Acetic, CH_3CO_2H	239	
Propionic, $CH_3CH_2CO_2H$	211.7	
<i>n</i> -Butyric, $CH_3(CH_2)_2CO_2H$	115.2	
<i>n</i> -Valeric, $CH_3(CH_2)_3CO_2H$	123.2	
Caproic, $CH_3(CH_2)_4CO_2H$	118.7	
<i>n</i> -Heptylic, $CH_3(CH_2)_5CO_2H$	120.9	
Caprylic, $CH_3(CH_2)_6CO_2H$	125.8	
<i>n</i> -Nonylic, $CH_3(CH_2)_7CO_2H$	123.5	
Capric, $CH_3(CH_2)_8CO_2H$	119.3	
Lauric, $CH_3(CH_2)_{10}CO_2H$	121.9	
Myristic, $CH_3(CH_2)_{12}CO_2H$	120.9	
Palmitic, $CH_3(CH_2)_{14}CO_2H$	114.4	
Stearic, $CH_3(CH_2)_{16}CO_2H$	123.7	
Cinnamic, $C_6H_5CH:CHCO_2H$	11.07	
β -Ethylacrylic, $C_2H_5CH:CHCO_2H$	17.18	
Allylacetic, $CH_2:CHCH_2CO_2H$	45.92	
Phenylisocrotonic, $C_6H_5CH:CHCH_2CO_2H$	81.8	
Ethylidenepropionic, $CH_3CH:CHCH_2CO_2H$	85.4	
Cyclohexanecarboxylic, $C_6H_{11}CO_2H$	19.5	
Benzoic, $C_6H_5CO_2H$	0.251	
Phenylacetic, $C_6H_5CH_2CO_2H$	50.2	
β -Phenylpropionic, $C_6H_5(CH_2)_2CO_2H$	46.8	
γ -Phenyl- <i>n</i> -butyric, $C_6H_5(CH_2)_3CO_2H$	56.9	
δ -Phenyl- <i>n</i> -valeric, $C_6H_5(CH_2)_4CO_2H$	39.2	
Furylpropionic, $OC(H):CHCH:C-$ $(CH_2)_2CO_2H$	43.5	
α -Phenylpropionic, $CH_3CH(C_6H_5)CO_2H$	9.67	
α -Phenylbenzylacetic, $C_6H_5CH_2CH(C_6H_5)-$ CO_2H	3.59	
Undecylenic, $CH_2:CH(CH_2)_8CO_2H$	53.0	
Oleic, $CH_3(CH_2)_7CH:CH(CH_2)_7CO_2H$	54.4	
Elaidic, $CH_3(CH_2)_7CH:CH(CH_2)_7CO_2H$	54.4	
Erucic, $CH_3(CH_2)_7CH:CH(CH_2)_{11}CO_2H$	51.2	
Brassicic, $CH_3(CH_2)_7CH:CH(CH_2)_{11}CO_2H$	51.8	
Phenyl- β - γ -crotonic, $C_6H_5CH:CHCH_2CO_2H$	85.4	

CATALYTIC ESTERIFICATION OF ACIDS.—(Continued)

Acid	k_s , 15°	k_s , 20°
Allylacetic, $CH_2:CH(CH_2)_2CO_2H$	45.1	
Hydrosorbic, $CH_3CH_2CH:CHCH_2CO_2H$	69.6	
Phenylpropylidenecacetic, $C_6H_5(CH_2)_2-$ $CH:CHCO_2H$	1.328	
Phenylethylidenepropionic, $C_6H_5CH_2CH:CH-$ CH_2CO_2H	81.8	
Cinnamylacetic, $C_6H_5CH:CHCH_2CO_2H$	48.4	
Cinnamalacetic, $C_6H_5CH:CHCH:CHCO_2H$	0.732	
Sorbic, $CH_3CH:CHCH:CHCO_2H$	0.737	
α , β -Oleic, $CH_3(CH_2)_{14}CH:CHCO_2H$	1.311	
Allocinnamic, $C_6H_5CH:CHCO_2H$	0.882	
Tetrollic, $CH_3C:CCO_2H$	1.274	
Phenylacetic, $C_6H_5CH_2CO_2H$	53.80	71.10
Chloroacetic, CH_2ClCO_2H	37.0	56.2
Bromoacetic, CH_2BrCO_2H	38.7	
Iodoacetic, CH_2ICO_2H	30.4	
Cyanoacetic, $CH_2(CN)CO_2H$	3.4	
Phenoxyacetic, $CH_2(OC_6H_5)CO_2H$	40.1	
Dichloroacetic, $CHCl_2CO_2H$		6.29
Trichloroacetic, CCl_3CO_2H	0.969	
Benzoic, $C_6H_5CO_2H$	0.238	0.437
<i>o</i> -Toluic, $CH_3C_6H_4CO_2H$	0.092	
<i>o</i> -Ethylbenzoic, $C_2H_5C_6H_4CO_2H$	0.056	0.092
<i>o</i> -Propylbenzoic, $C_3H_7C_6H_4CO_2H$	0.049	
<i>o</i> -Diphenylcarboxylic, $C_6H_5C_6H_4CO_2H$	0.051	
<i>o</i> -Salicylic, $C_6H_4(OH)CO_2H$	0.0129	0.0235
<i>o</i> -Phenoxybenzoic, $C_6H_4(OC_6H_5)CO_2H$	0.471	
Acetophenone- <i>o</i> -carboxylic, $CH_3COC_6H_4CO_2H$	7.69	
<i>o</i> -Chlorobenzoic, $C_6H_4(Cl)CO_2H$	0.105	
<i>o</i> -Bromobenzoic, $C_6H_4(Br)CO_2H$	0.085	0.123
<i>o</i> -Iodobenzoic, $C_6H_4(I)CO_2H$	0.0625	0.0936
<i>o</i> -Nitrobenzoic, $C_6H_4(NO_2)CO_2H$	0.0088	
<i>o</i> -Benzoylbenzoic, $C_6H_5COC_6H_4CO_2H$		0.244
<i>o</i> -Naphthoylbenzoic, $C_{10}H_7COC_6H_4CO_2H$		0.0897

Catalytic Esterification in Absolute CH_3OH (Dehydrated by Metallic Ca)Titrimetric method; k_s monomolecular constant referred to $[HCl] = 1$; *t* in hours; $\theta = 25^\circ C$; values of k_s decrease; initial value of k_s given (227).

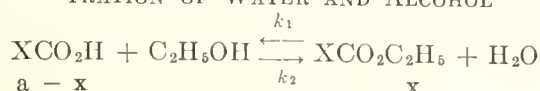
Acid	k_s
Acetic, CH_3CO_2H	178.7
Phenylacetic, $C_6H_5CH_2CO_2H$	82.12
Diphenylacetic, $(C_6H_5)_2CHCO_2H$	4.66
Triphenylacetic, $(C_6H_5)_3CCO_2H$	0.0116
<i>p</i> -Tolylacetic, $CH_3C_6H_4CH_2CO_2H$	86.41
Phenyl- <i>p</i> -tolylacetic, $CH_3C_6H_4CH(C_6H_5)CO_2H$	5.09
Diphenyl- <i>p</i> -tolylacetic, $CH_3C_6H_4C(C_6H_5)_2CO_2H$	0.0040
<i>p</i> -Hydroxyphenylacetic, $CH_2(C_6H_4OH)CO_2H$	91.64
<i>p</i> -Hydroxydiphenylacetic, $C_6H_5CH(C_6H_4OH)CO_2H$	4.73
<i>p</i> -Hydroxytriphenylacetic, $(C_6H_5)_2C(C_6H_4OH)CO_2H$	0.0078
Glycolic, $CH_2(OH)CO_2H$	227.1
Mandelic, $C_6H_5CH(OH)CO_2H$	71.34
Benzilic, $(C_6H_5)_2C(OH)CO_2H$	0.407
Chloroacetic, CH_2ClCO_2H	54.24
Phenylchloroacetic, $C_6H_5CHClCO_2H$	10.25

For the influence of degree of dehydration of methyl alcohol on the constant of catalytic esterification, see (228). For the retarding effect of small amounts of water, see (200, 201, 203, 220). For esterification of mercaptans, see (174, 187, 298, 430).

Dynamics of Esterification- and Acetalization-Equilibrium

See the classic work of (37, 226, 259, 304, 356).

DYNAMICS OF ESTER EQUILIBRIUM WITH CONSTANT CONCENTRATION OF WATER AND ALCOHOL



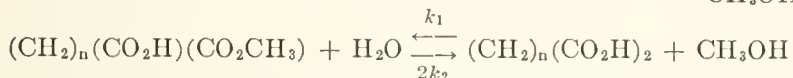
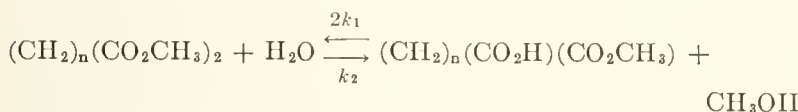
$$\frac{dx}{dt} = k_1(a - x) - k_2x$$

$$k_1 + k_2 = \frac{1}{t} \log_e \frac{\xi}{\xi - x}; \xi = x \text{ for } t = \infty; \frac{k_1}{k_2} = \frac{\xi}{a - \xi}$$

Titrimetric method; t in minutes; $\theta = 24.8^\circ\text{C}$; catalyst, 0.026*N* HCl (300)

% C ₂ H ₅ OH	Substrate	10 ⁵ (<i>k</i> ₁ + <i>k</i> ₂)	10 ⁵ <i>k</i> ₁	10 ⁵ <i>k</i> ₂
56.5	CH ₃ CO ₂ H.....	32.70	19.80	12.90
56.7	CH ₃ CO ₂ C ₂ H ₅	32.93	19.94	12.99
56.5	HCO ₂ H.....	360.9	175.5	185.4
56.5	HCO ₂ C ₂ H ₅	358.1	173.9	184.2
50.2	HCO ₂ H.....	370.8	159.4	211.4
50.5	HCO ₂ C ₂ H ₅	368.5	158.4	210.1
43.9	HCO ₂ H.....	393.8	153.6	240.2
43.9	HCO ₂ C ₂ H ₅	393.8	153.6	240.2

EFFECT OF LENGTHENING THE CARBON CHAIN



Titrimetric method; t in hours; $\theta = 25^\circ\text{C}$; catalyst, 0.05*N* HCl; solvent = 50 Vol. % CH₃OH (397.8)

$$k_1 + k_2 = \frac{1}{t} \log_e \frac{U - u_0}{U - u}$$

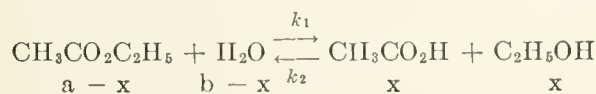
u_0, u, U = Titer for time = 0, t , ∞ .

k_1 = Saponification velocity } reduced to *N* HCl.
 k_2 = Esterification velocity }

Methyl ester of:	<i>n</i>	<i>k</i> ₁ + <i>k</i> ₂	<i>k</i> ₁	<i>k</i> ₂	<i>k</i> ₁ : <i>k</i> ₂
Oxalic acid.....	0	0.554	0.308	0.246	1.256
Malonic acid.....	1	0.153	0.051	0.102	0.496
Succinic acid.....	2	0.220	0.065	0.155	0.417
Glutaric acid.....	3	0.546	0.152	0.394	0.386
Adipic acid.....	4	0.618	0.170	0.448	0.380
Pimelic acid.....	5	0.626	0.172	0.454	0.379
Suberic acid.....	6	0.664	0.178	0.486	0.366
Azelaic acid.....	7	0.632	0.169	0.463	0.366
Sebacic acid.....	8	0.504	0.112	0.392	0.286
<i>n</i> -Butyric acid.....		0.667	0.186	0.491	0.377

n-Butyric acid is introduced for comparison. In the series of oxalic acid homologues, k_1 and k_2 are at a minimum for malonic acid and at a maximum for suberic acid; cf. (453, 469, 472).

DYNAMICS OF ESTER EQUILIBRIUM WITH VARYING CONCENTRATIONS OF WATER AND ALCOHOL



Titrimetric method; units: minutes and M/l; catalyst, HCl; $\theta = 25^\circ\text{C}$ (242)

$$\frac{dx}{dt} = k_1(a - x)(b - x) - k_2x^2.$$

$$k_1 = \frac{l}{t} \log_e \frac{n - mx}{n - 2(1 - K)x}$$

$$l = \frac{1}{\sqrt{(a + b)^2 - 4ab(1 - K)}}$$

$$m = \frac{(a + b) - \sqrt{(a + b)^2 - 4ab(1 - K)}}{(a + b) + \sqrt{(a + b)^2 - 4ab(1 - K)}} \times 2(1 - K).$$

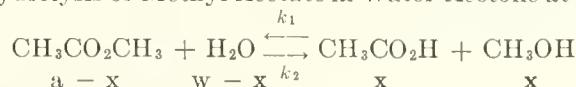
$$n = (a + b) - \sqrt{(a + b)^2 - 4ab(1 - K)}.$$

$$K = \frac{k_2}{k_1}, \text{ equilibrium constant.}$$

Determinations with ester concentration, a , = 0.470.

[HCl]	<i>K</i>	10 ⁵ <i>k</i> ₁ : [HCl]
0.01	3.39	116.7
0.03	3.87	114.7
0.05	3.50	114.5
0.07	3.89	113.9
0.10	3.87	114.6
0.15	3.61	115.8
0.20	4.01	116.3
0.30	4.00	117.8
0.50	3.93	120.1
0.70	3.68	122.9
1.00	3.35	125.2
1.50		130.8

Acid Hydrolysis of Methyl Acetate in Water-Acetone at 25°C (102)



$$\frac{dx}{dt} = k_1(a - x)(w - x) - k_2x^2.$$

$$k_1 = \frac{1}{tA} \log_e \frac{A + y + 2(K - 1)x}{A - y - 2(K - 1)x} \times \frac{A - y}{A + y}$$

$$y = a + w.$$

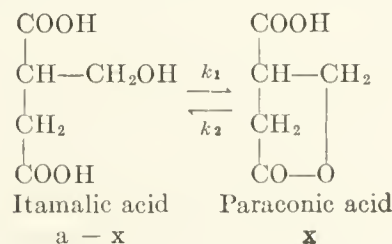
$$A = \sqrt{(a + w)^2 + 4(K - 1)aw}.$$

$$K = \frac{k_2}{k_1}, \text{ equilibrium constant; } a = 0.6267; c = \text{acetone, M/l.}$$

Titrimetric method; units: M/l and minutes; catalyst, 0.5*N* HCl

Vol. % (CH ₃) ₂ CO	<i>c</i>	<i>w</i>	<i>K</i>	10 ⁵ <i>k</i> ₁
0	0	52.32	5.40	6.36
20	2.665	42.26	5.10	6.98
40	5.39	32.08	4.39	7.88
60	8.10	21.23	4.47	8.89
70	9.42	15.72	4.51	10.50
80	10.66	10.20	5.14	17.04
90	11.84	4.752	8.97	45.05

For acid hydrolysis of ethyl formate in water-acetone, see (332)

DYNAMICS OF HYDROLYSIS OF γ -LACTONES IN AQUEOUS SOLUTION

$$\frac{dx}{dt} = k_1(a - x) - k_2x.$$

$$t = \infty; x = \xi = \frac{ak_1}{k_1 + k_2}.$$

$$k_1 + k_2 = \frac{1}{t} \log_e \frac{\xi}{\xi - x}.$$

$$K = \frac{k_1}{k_2} = 1.10, \text{ equilibrium constant.}$$

HYDROLYSIS OF γ -LACTONES—(Continued)

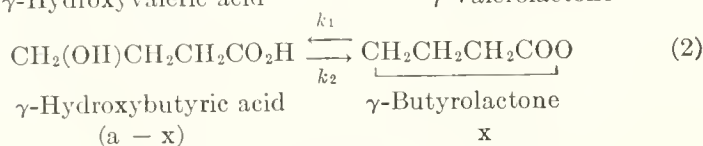
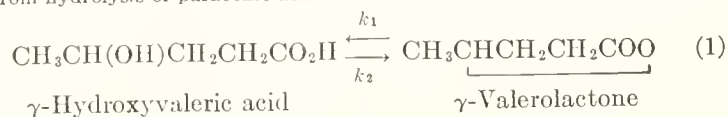
Titrimetric method; units: hours and M/l; catalyst, HNO_3 ;
 $a = 0.025$; $\theta = 25^\circ\text{C}$ (268)

$N \text{ HNO}_3$	$(k_1 + k_2)^*$	$(k_1 + k_2)^\dagger$
0.0125	0.014	0.014
0.0250	0.031	0.0305

$$k_1 = 0.58 [\text{H}^+], k_2 = 0.53 [\text{H}^+], K = \frac{0.58}{0.53} = 1.1.$$

* From lactonization of itamic acid.

† From hydrolysis of paraconic acid.



Titrimetric or conductivity method; units: minutes and M/l;
 $\theta = 25^\circ\text{C}$ (195, 246, 282, 291, 509)

C = concentration of catalyst.

$$k_1 = [\text{H}^+]k_l, k_2 = [\text{H}^+]k_s, [\text{H}^+] = C.$$

$$K = \frac{k_l}{k_s} = \frac{[\text{Lactone}]}{[\text{Hydroxy acid}]}, \text{ equilibrium constant.}$$

$$K \text{ for butyrolactone} = 2.683 \text{ (246)}; = 2.66 \text{ (291)}; \text{ mean} = 2.67.$$

$$K \text{ for valerolactone} = 13.71 \text{ (246)}; = 13.86 \text{ and } 13.7 \text{ (291)}; \\ = 11.5 \text{ (509)}; = 15.7 \text{ (195)}; \text{ mean} = 13.8.$$

Reaction without Catalyst

If α is the degree of dissociation of the hydroxy acid, κ its dissociation constant, then, under the assumption that only the undissociated hydroxy acid is converted to lactone:

$$\frac{dx}{dt} = k_l\alpha(1 - \alpha)(a - x)^2 - k_s\alpha(a - x)x$$

$$\alpha^2(a - x) = (1 - \alpha)\kappa; \text{ or, since } 1 \gg \alpha, \alpha = \sqrt{\frac{\kappa}{a - x}}$$

$$k_l + k_s = \frac{1}{t \sqrt{1 + K}} \times$$

$$\log_s \left(\frac{\left(\sqrt{\frac{a}{1 + K}} + \sqrt{a - x} \right) \left(\sqrt{\frac{a}{1 + K}} - \sqrt{a} \right)}{\left(\sqrt{\frac{a}{1 + K}} - \sqrt{a - x} \right) \left(\sqrt{\frac{a}{1 + K}} + \sqrt{a} \right)} \right)$$

$$\kappa = 1.94 \times 10^{-5} \text{ for } \gamma\text{-hydroxybutyric acid}; \kappa = 0.202 \times 10^{-5} \text{ for } \gamma\text{-hydroxyvaleric acid.}$$

Reaction 1 (291)

a	0.04295	0.0617	0.1297	0.1429	0.1789
$k_l + k_s$	0.153	0.148	0.146	0.144	0.144

Mean: 0.148.

Reaction 2 (291): $k_l + k_s = 0.0509$.

Reaction with HCl (HNO_3) as Catalyst

$$\frac{dx}{dt} = k_l C (a - x) - k_s C x$$

$$k_l + k_s = \frac{1}{tC} \log_s \frac{\xi}{\xi - x}; x = \xi \text{ for } t = \infty$$

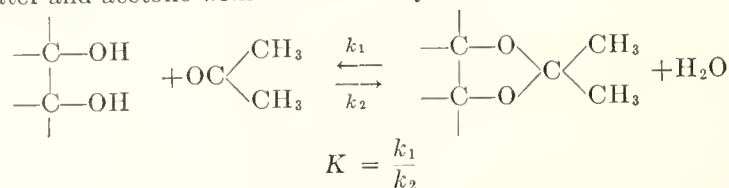
Means of all determinations

Reaction	$k_l + k_s$	K	k_l	k_s
1	0.156	13.8	0.145	0.0106
2	0.0506	2.67	0.0368	0.0138

For the effect of temperature, the use of activity in place of concentration, the effect of electrolytes (KCl , LiCl) and of non-electrolytes (sugar) on the velocity, see the original literature.

DYNAMICS OF ACETALIZATION EQUILIBRIUM

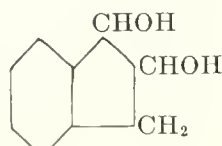
Acetalization of diols by acetone at constant concentrations of water and acetone with HCl as catalyst:



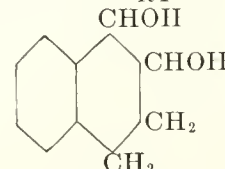
$$k_1 + k_2 = \frac{1}{t} \log_s \frac{\xi}{\xi - x}; x = \xi \text{ for } t = \infty$$

Titrimetric method; units: hours and M/l (247)

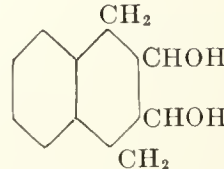
$$\log_s k = -\frac{E}{RT} + J$$



A: *cis*-1, 2-Hydrindenediol



B: Tetrahydronaphthalenediol



C: *dl*-Hydrobenzoin (inactive analog of antitartaric acid)
 D: *dl*-Hydrobenzoin (inactive analog of antitartaric acid)
 E: *r*-Hydrobenzoin (inactive analog of racemic acid)

Solvent and catalyst:	$[\text{H}_2\text{O}]:[(\text{CH}_3)_2\text{CO}]$	$[\text{HCl}]$
For the three cyclic diols.....	2.310	0.00018
For the two hydrobenzoins.....	0.9809	0.0106

Diol:	A	B	C	D	E
k_1 , 24.9°*.....	0.0138	0.00644	0.00144	0.00263	0.0230
k_1 , 44.5°.....	0.0736	0.0396	0.0123	0.0212	0.130
k_2 , 24.9°*.....	0.00160	0.00122	0.000522	0.00598	0.00269
k_2 , 44.5°.....	0.0150	0.0125	0.00712	0.0793	0.0304
k_1 , E.....	16 100	17 500	20 600	20 200	16 700
k_1 , J.....	22.7	24.3	28.1	27.9	24.3
k_2 , E.....	21 600	22 500	25 100	23 900	21 900
k_2 , J.....	29.7	31.0	34.6	35.0	30.8
k_1 , Q_{10} †.....	2.23	2.36	2.76	2.69	2.26
k_2 , Q_{10} †.....	2.90	3.06	3.49	3.27	2.94

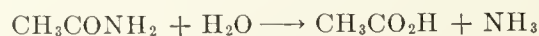
* For D and E the temperature is 25.0°C .

† Q_{10} holds for the interval $25\text{--}35^\circ\text{C}$.

On account of the equilibrium position, the measurements of $(k_1 + k_2)$ for A, B and E were made starting from the diol; for C and D from the acetonal. For the dynamics of acetalization of CH_2O with various alcohols, see (145).

Hydrolysis of Nitriles, Acid Amides and the Inverse Reactions

HYDROLYSIS OF ACETAMIDE IN AQUEOUS SOLUTION



$$(a - x)$$

$$\frac{dx}{dt} = k_s [\text{H}^+](a - x) + k_a [\text{OH}^-](a - x)$$

Titrimetric and gas-volumetric methods; t in minutes (173, 402);
 cf. (13, 129, 295, 395, 414)

Constant	Value	$^\circ\text{C}$	Lit.
k_a	0.0024	25	(402)
k_s	0.000377	25	
k_s^*	0.00777	49.3	(173)
k_s^*	0.0223	64.3	

* $E = 15\,400$.

For dynamics of equilibrium in glacial acetic acid solution, see (387).

HYDROLYSIS OF ACETANILIDE IN AQUEOUS SOLUTION



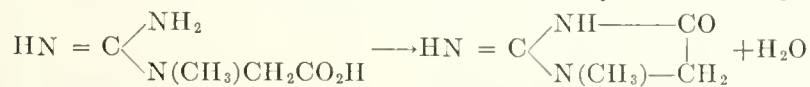
(a - x)

$$\frac{dx}{dt} = k_s[\text{H}^+](a - x) + k_a[\text{OH}^-](a - x)$$

Titrimetric method; t in hours; $\theta = 100^\circ\text{C}$; $k_s = 8.4 \pm 0.1$ (358);
 $k_a = 3.2$ (137)

In NaOH and HCl solution the reaction runs to completion; in $\text{CH}_3\text{CO}_2\text{H}$ solution it is perceptibly reversible.

CONVERSION OF CREATINE INTO CREATININE IN AQUEOUS SOLUTION

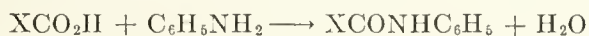


The reaction is reversible. In strongly acid solution it runs to completion.

Titrimetric method; first-order k for t in minutes; if $[\text{HCl}] \gg a$, $[\text{H}^+] = \text{constant}$; a = initial concentration of creatine in M/l (161).

$^\circ\text{C}$	$[\text{HCl}]$	a	10^3k	Q_{10}
25	0.38	0.0075	0.00340	
57	0.38	0.0300	0.0777	2.66
78	0.38	0.0075	0.494	2.41
100	0.38	0.0075	2.816	2.21
100	0.19	0.00367	1.367	
78	0.19	0.00447	0.256	2.14
78	0.76	0.0300	1.235	
78	0.76	0.0150	1.256	

$E = 20\,000$ as average independent of $[\text{HCl}]$.

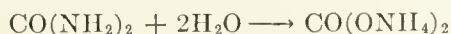
KINETICS OF ANILIDE FORMATION FROM ORGANIC ACIDS IN ANILINE (RESP. *o*-TOLUIDINE) AS SOLVENT

Titrimetric method; units: hours and M/l; $\theta = 100^\circ\text{C}$ (206, 221)

With respect to XCO_2H , the reaction is of second-order (constant, k_2); in the presence of picric acid (concn., c) as catalyst, it is of first-order (constant, k_1) and the velocity is approximately proportional to c .

Solvent, XCO_2H	Aniline, k_2	<i>o</i> -Toluidine, k_2	Aniline, $c = 0.5$, k_1
$\text{CH}_3\text{CO}_2\text{H}$	0.039	0.013	0.070
$\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$	0.021		0.043
$\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{H}$	0.0126	0.0050	0.026
$(\text{CH}_3)_2\text{CHCO}_2\text{H}$	0.0052	0.0023	0.011
HCO_2H in Aniline, k_2	1.77(45°)		3.30(55°)
HCO_2H in <i>o</i> -Toluidine, k_2	0.87(45°)		1.44(55°)

HYDROLYSIS OF UREA IN AQUEOUS AND ACID SOLUTIONS



Titrimetric method; first-order k for t in minutes; $\theta = 100^\circ\text{C}$ (176, 410)

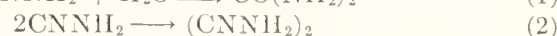
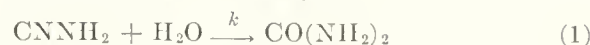
N = normality of acid, HCl (176); HNO_3 (410)

N	$10^5k(\text{HNO}_3)$	$10^5k(\text{HCl})$
2	168	
1	201	133
0.5	246	177
0.25	255	207
0.125	267	232
0.0625	306	232

Effect of temperature on reaction mixture, 0.5*N* $\text{CO}(\text{NH}_2)_2$ + 0.5*N* HNO_3

$^\circ\text{C}$	100	89	80	70
10^5k	235	53.0	21.4	3.5

HYDROLYSIS OF CYANAMIDE IN AQUEOUS SOLUTION



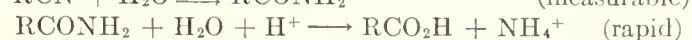
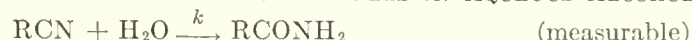
Titrimetric method; monomolecular k [reaction (1)] for t in minutes in 0.06 molal H_2SO_4 ; $k = 0.00189$; $\theta = 50^\circ\text{C}$ (251)

In alkaline solution in addition to reaction (1) apparently catalyzed by OH^- , reaction (2) also proceeds; t in hours; N_e , (resp. N_u , N_d) = % N of cyanamide (resp. urea, diacyandiamide).

t	NaOH, N			0.01			0.1			1.0		
	N_e	N_u	N_d	N_e	N_u	N_d	N_e	N_u	N_d	N_e	N_u	N_d
1	92.1	2.9	5.0	69.6	3.2	17.2	94.0	5.0	1.0			
2	90.4	3.3	6.3	55.6	3.8	40.6	92.3	7.0	0.7			
3	85.5	3.3	10.9	44.4	4.1	51.5	89.3	8.3	2.4			
20	47.2	4.9	47.9	14.1	10.1	75.8	62.7	34.4	2.9			

For both reactions, see also (223, 373).

ACID HYDROLYSIS OF NITRILES IN AQUEOUS ALCOHOL



$$\frac{dx}{dt} = k(a - x)(b - x)$$

Volumetric method; units: minutes and M/l; solvent 46.2% $\text{C}_2\text{H}_5\text{OH}$ (27.3M H_2O + 13.2M $\text{C}_2\text{H}_5\text{OH}/\text{l}$); catalyst, HCl; k , corrected for the formation of $\text{C}_2\text{H}_5\text{Cl}$ (297).

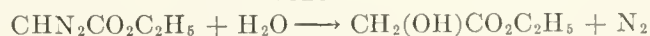
$$A' = \frac{T_1 T_2 (\log_{10} k_1 - \log_{10} k_2)}{T_1 - T_2}$$

Nitrile	10^3k		
	74°	110°	A'
CH_3CN	0.0242	0.76	5530
$\text{CH}_3\text{CH}_2\text{CN}$	0.0363	1.17	5640
$\text{CH}_3(\text{CH}_2)_2\text{CN}$		0.715	
$\text{CH}_3(\text{CH}_2)_3\text{CN}$	0.0224	0.66	5430
$\text{CH}_3\text{OCH}_2\text{CN}$	0.0595		
$\text{CH}_3\text{CH}_2\text{OCH}_2\text{CN}$	0.0550	1.44	5260
$\text{CH}_3(\text{CH}_2)_2\text{OCH}_2\text{CN}$		1.52	
$\text{CH}_3\text{O}(\text{CH}_2)_2\text{CN}$		0.62	6010
$\text{CH}_3\text{CH}_2\text{O}(\text{CH}_2)_2\text{CN}$	0.0161		
$\text{CH}_3\text{O}(\text{CH}_2)_3\text{CN}$		0.77	
$\text{CH}_3\text{CH}_2\text{O}(\text{CH}_2)_3\text{CN}$	0.0239		

For the alkaline saponification of nitriles, see (402).

Hydrolysis of Diazo Compounds

KINETICS OF DECOMPOSITION OF DIAZOACETIC ESTER IN AQUEOUS SOLUTION



Catalysis of Reaction by Acids

Gas-volumetric method; monomolecular k for t in minutes; $\theta = 25^\circ\text{C}$; e = concentration of catalyst (67)

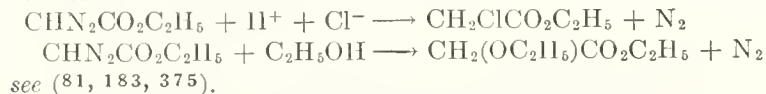
Catalyst	10^3e	$10^3[\text{H}^+]$	$100k$	$k: [\text{H}^+]$
HNO_3	1.82	1.82	7.03	38.7
	0.909	0.909	3.51	38.6
	0.909	0.909	3.37	37.1
$\text{C}_6\text{H}_2(\text{OH})(1)(\text{NO}_2)_3(2, 4, 6)$...	0.909	0.909	3.63	39.9
	0.909	0.909	3.45	38.0
	0.364	0.364	1.37	37.6
	0.364	0.364	1.42	39.0
$\text{C}_6\text{H}_4(\text{NO}_2)(3)(\text{CO}_2\text{H})(1)$	9.90	1.68	6.40	38.1
	9.90	1.68	6.25	37.2
$\text{CH}_3\text{CO}_2\text{H}$	18.2	5.63	2.20	39.1
	18.2	5.63	2.14	38.0

$$\frac{d[\text{N}_2]}{dt} = 38.5[\text{H}^+][\text{CHN}_2\text{CO}_2\text{C}_2\text{H}_5]$$

Effect of temperature
 $\log_e \frac{k_1}{k_2} = A \frac{T_1 - T_2}{T_1 T_2}$; $A = 8869$; $k_s = k: [H^+]$

°C.....	15	25	35	45
k_6 , obs.....	13.7	38.5	102	246
k_8 , calc.....	(13.7)	(38.5)	104	250
Q_{10}		2.80	2.64	2.43

For adiabatic kinetics of the reaction, see (72, 326). For kinetics of the reactions:

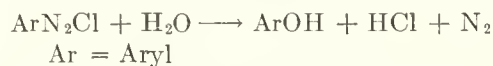


Determination of $[H^+]$ in a Solution of $\text{K}_2\text{Cr}_2\text{O}_7$ from the Velocity of Diazoacetic Ester Catalysis at 25°C (495)

$\text{K}_2\text{Cr}_2\text{O}_7$	$10^4 k$, obs.	$10^4 [H^+]$, calc.
0.2208	173	4.49
0.1206	117	3.04
0.1012	100	2.60
0.0603	72.2	1.88
0.0483	65.2	1.69
0.0302	48.4	1.27
0.0169	37.8	0.95

For further application of this method, see (131, 262, 534).

DECOMPOSITION OF AROMATIC DIAZONIUM SALTS IN AQUEOUS SOLUTION



Titrimetric and colorimetric methods; monomolecular k for t in minutes, $k' = 0.4343k$; $\theta = 25^\circ\text{C}$ (235)

Ar	$10^4 k'$
Benzene.....	6.4-7.2
<i>p</i> -Toluene.....	0.81
<i>p</i> -Bromobenzene.....	Very small
Anisole.....	Very small
Pseudocumene.....	30-44

The reaction is not influenced by acids.

Methods and units as above (166)

Diazonium chloride of*:	$10^4 k'$	$10^4 k'$, 50° (extrap.)
Benzene.....	12.2 (25°)	270
<i>o</i> -Toluene.....	35 (25°)	770
<i>m</i> -Toluene.....	37 (25°)	800
<i>p</i> -Toluene.....	0.81 (25°)	18
Pseudocumene.....	31 (25°)	680
<i>m</i> -Benzoic acid.....	12 (25°)	264
<i>p</i> -Benzoic acid.....	2.7 (25°)	59
<i>o</i> -Anisole.....	4.0 (80°)	0.11
<i>p</i> -Anisole.....	4.4 (80°)	0.12
<i>o</i> -Chlorobenzene.....	0.80 (80°)	0.068
<i>m</i> -Chlorobenzene.....	11.5 (50°)	
<i>p</i> -Chlorobenzene.....	5.1 (60°)	1.5
<i>m</i> -Bromobenzene.....	15.0 (45°)	30
<i>p</i> -Bromobenzene.....	2.3 (50°)	

* The italicized letters indicate the position of the N_2Cl group in the compound.

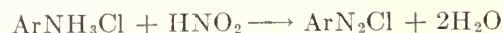
The anion of the diazonium salt is without appreciable influence.

Effect of temperature

$\text{C}_6\text{H}_5\text{N}_2\text{Cl}$			<i>p</i> -Br $\text{C}_6\text{H}_4\text{N}_2\text{Cl}$		
°C	$10^3 k'$	Q_{10}	°C	$10^3 k'$	Q_{10}
15	0.31		40	0.062	
25	1.22	3.93	50	0.23	3.72
30	2.40	3.87	70	2.8	3.49
A = 11 905			A = 13 634		

Kinetics of Diazotization and Coupling Processes

KINETICS OF DIAZOTIZATION IN AQUEOUS SOLUTION



The velocity of diazotization is proportional to the concentrations of amine salt and nitrous acid.

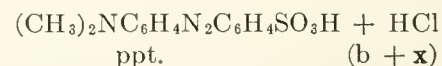
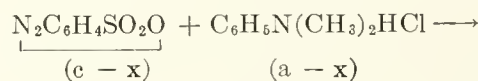
Colorimetric method; the velocity was only slightly influenced by excess acid; second-order k ; units: minutes and M/l; $\theta = 0^\circ\text{C}$ (54, 238); cf. (437, 505, 506).

Salt of amine	k (54)	k (238)
$\text{C}_6\text{H}_5\text{NH}_2$	48.3	36
$\text{C}_6\text{H}_3(\text{CH}_3)_2(2, 4)\text{NH}_2$	44.3	41
$\text{C}_6\text{H}_4(\text{CH}_3)(2)\text{NH}_2$	46.4	
$\text{C}_6\text{H}_4(\text{CH}_3)(4)\text{NH}_2$	34.4	38
$\text{C}_6\text{H}_4(\text{CH}_3)(3)\text{NH}_2$	68.5	
$\text{C}_6\text{H}_4\text{Cl}(2)\text{NH}_2$	241.5	
$\text{C}_6\text{H}_4\text{Cl}(4)\text{NH}_2$	76.5	
$\text{C}_6\text{H}_4\text{Cl}(3)\text{NH}_2$	67.5	
$\text{C}_6\text{H}_4\text{Br}(2)\text{NH}_2$	225.0	
$\text{C}_6\text{H}_4\text{Br}(4)\text{NH}_2$	64.5	45
$\text{C}_6\text{H}_4\text{Br}(3)\text{NH}_2$	71.0	
$\text{C}_6\text{H}_4\text{I}(2)\text{NH}_2$	226.5	
$\text{C}_6\text{H}_4\text{I}(4)\text{NH}_2$	75.2	
$\text{C}_6\text{H}_4\text{I}(3)\text{NH}_2$	75.7	
$\text{C}_6\text{H}_4(\text{SO}_3\text{H})(2)\text{NH}_2$	483.0	
$\text{C}_6\text{H}_4(\text{SO}_3\text{H})(4)\text{NH}_2$	123.5	
$\text{C}_6\text{H}_4(\text{SO}_3\text{H})(3)\text{NH}_2$	53.5	
$\text{C}_6\text{H}_4(\text{CO}_2\text{H})(2)\text{NH}_2$	880.5	
$\text{C}_6\text{H}_4(\text{CO}_2\text{H})(4)\text{NH}_2$	160.5	
$\text{C}_6\text{H}_4(\text{CO}_2\text{H})(3)\text{NH}_2$	72.5	
$\text{C}_6\text{H}_4(\text{NO}_2)(3)\text{NH}_2$	565.0	

KINETICS OF THE COUPLING PROCESS IN AQUEOUS SOLUTION

Gas-volumetric determination of diazonium salt; units: minutes and M/l (208, 209, 211, 212, 214).

Formation of Aminoazo Compounds in Strongly Acid (HCl) Solutions



κ = hydrolysis constant of amine salt.

ξ = concn. of free amine.

$$\xi = \kappa \frac{(a - x)}{(b + x)}$$

The diazonium salt and free amine react, therefore, as follows:

$$\frac{dx}{dt} = k\xi(c - x) = k\kappa \frac{(a - x)(c - x)}{(b + x)}$$

k = bimolecular constant.

Diazonium salt	Salt of amine	°C	$k\kappa$
<i>p</i> - $\text{N}_2\text{C}_6\text{H}_4\text{SO}_2\text{O}$	$\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$	20	0.0053
		25	0.0086
		30	0.0135
	$\text{C}_6\text{H}_5\text{N}(\text{C}_2\text{H}_5)_2$	20	0.00095
		25	0.00145
		30	0.00246
	$\text{C}_6\text{H}_5\text{N}(\text{CH}_2\text{CH}_2\text{CH}_3)_2$	20	0.00202
		25	0.00365
	<i>m</i> - $\text{CH}_3\text{C}_6\text{H}_4\text{N}(\text{CH}_3)_2$	20	0.0606
		25	0.0797
	<i>m</i> - $\text{CH}_3\text{C}_6\text{H}_4\text{N}(\text{C}_2\text{H}_5)_2$	20	0.00709
		25	0.0104
	<i>m</i> - $\text{ClC}_6\text{H}_4\text{N}(\text{CH}_3)_2$	25	0.0099
		20	0.00147
		25	0.00215

Formation of Aminoazo Compounds.—(Continued)

Diazonium salt	Salt of amine	°C	$k\kappa$
$m\text{-C}_6\text{H}_4(\text{NO}_2)\text{N}_2\text{NO}_3$	$\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$	20	0.135
	$\text{C}_6\text{H}_5\text{N}(\text{C}_2\text{H}_5)_2$	20	0.023
$p\text{-C}_6\text{H}_4(\text{NO}_2)\text{N}_2\text{NO}_3$	$\text{C}_6\text{H}_5\text{N}(\text{C}_2\text{H}_5)_2$	20	0.022
$m\text{-N}_2\text{C}_6\text{H}_4\text{SO}_2\text{O}$	$\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$	20	0.0054

Formation of Aminoazo Compounds in Solution of Weak Acids (HA)



(c - x)

(a - x)



ppt.

(b + x)

 κ = hydrolysis constant of amine salt. ξ = concn. of free amine. δ = dissociation constant of acid, HA.If b is sufficiently great with respect to a ($b \geq 10a$), then

$$[\text{H}^+] = \delta \frac{(b+x)}{(a-x)}$$

$$\xi[\text{H}^+] = \kappa \frac{(a-x)}{(a-x)^2}$$

$$\xi = \frac{\kappa}{\delta} \frac{(b+x)}{(b+x)}$$

The diazonium salt and the free amine react, therefore, as follows:

$$\frac{dx}{dt} = k\xi(c-x) = k\frac{\kappa}{\delta} \frac{(a-x)^2(c-x)}{(b+x)}$$

$$k\frac{\kappa}{\delta} = C$$

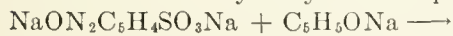
Between C and $k\kappa$ of the preceding tables, the relation $C = \frac{k\kappa}{\delta}$ must, therefore, hold; whereby C may be calculated from $k\kappa$ and δ .

Determinations with $p\text{-N}_2\text{C}_6\text{H}_4\text{SO}_2\text{O}$

HA	100 δ	Amine	°C	C , obs.	C , calc.
$\text{CH}_2\text{ClCO}_2\text{H}$	0.155	$\text{C}_6\text{H}_5\text{N}(\text{C}_2\text{H}_5)_2$	25	1.15	0.94
$\text{CH}_3\text{CO}_2\text{H}$	0.0018		25	77.7	80.6
			20	49.2	52.8
HCO_2H	0.0214	$\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$	20	25.8	25.0
		$\text{C}_6\text{H}_5\text{N}(\text{C}_2\text{H}_5)_2$	20	3.9	4.4
			25	7.0	6.8
$\text{C}_2\text{H}_5\text{CO}_2\text{H}$	0.00134		20	61.0	70.9
			25	108.7	108.2
$\text{CH}_3\text{CO}(\text{CH}_2)_2\text{CO}_2\text{H}$	0.00255		20	38.3	37.7
			25	57.3	57.0
$\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$..	0.0310		20	3.1	3.1
			25	5.0	4.7

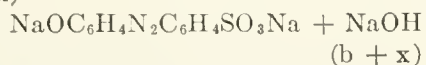
Measurements of k were also made in solutions saturated with respect to diazonium salt (c = constant). They yielded the same values for $k\kappa$ and for C .

Formation of Hydroxyazo Compounds in Alkaline Solution



(c - x)

(a - x)



(b + x)

 κ_1 = hydrolysis constant of phenolate. κ_2 = hydrolysis constant of diazotate. ξ = concn. of free phenol. η = concn. of free diazo acid.

$$\xi = \kappa_1 \frac{(a-x)}{(b+x)}; \eta = \kappa_2 \frac{(c-x)}{(b+x)}$$

Free phenol and free diazo acid react, therefore, as follows:

$$\frac{dx}{dt} = k\xi\eta = k\kappa_1\kappa_2 \frac{(a-x)(c-x)}{(b+x)^2}$$

Measurements with sodium *syn*-diazobenzene-*p*-sulfonic acid at 0°C

Hydroxy comp.....	Phenol	<i>o</i> -Cresol	<i>m</i> -Cresol
$k\kappa_1\kappa_2$	0.0008	0.01	0.01

Formation of Hydroxyazo Compounds.—(Continued)

Hydroxy comp.....	β -Naphthol	Thymol	Resorcinol
$k\kappa_1\kappa_2$	0.03	0.11	0.2
Measurements with sodium diazobenzene at 0°C			
Hydroxy comp.....	β -Naphthol	<i>m</i> -Cresol	
$k\kappa_1\kappa_2$	2.3	0.95	

Indirect Ether and Ester Formation

FORMATION OF ETHER FROM RBr IN $\text{C}_2\text{H}_5\text{OH}$ AS SOLVENT

Volumetric method; first-order k for t in minutes, $k' = 0.4343k$; $\text{C}_2\text{H}_5\text{OH}(\text{abs.})$ = commercial abs. alcohol (1% H_2O); $\text{C}_2\text{H}_5\text{OH}(\text{CaO})$ = alcohol dried over CaO (231). $10^5k'$ in $\text{C}_2\text{H}_5\text{OH}(\text{abs.})$ as solvent.

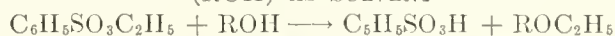
RBr	25°	45°	65°	65°*
$\text{C}_6\text{H}_5\text{CH}_2\text{Br}$	1.44	13.4	101	86
$\text{C}_6\text{H}_5\text{CH}_2\text{Cl}$			4.33	3.44
$\text{CH}_2:\text{CHCH}_2\text{Br}$	0.30	2.93	24.0	21.6
$\text{C}_2\text{H}_5\text{Br}$			2.39	1.73

* $\text{C}_2\text{H}_5\text{OH}(\text{CaO})$ as solvent.

In an inert solvent (*e.g.*, CH_3COCH_3) the reaction with respect to RBr and $\text{C}_2\text{H}_5\text{OH}$ is of the first-order, the total, therefore, of the second order.

 $A' = 4600$ for benzyl bromide; = 4750 for allyl bromide

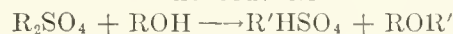
ETHER FORMATION FROM ESTERS OF SULFONIC ACID IN ALCOHOLS (ROH) AS SOLVENT



Titrimetric method; first-order k for t in minutes; $k' = 0.4343k$; $\theta = 100^\circ\text{C}$ (431)

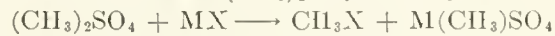
ROH	$10^5k'$	ROH	$10^5k'$
Methyl alcohol.....	2311	Allyl alcohol.....	649
Ethyl alcohol.....	1130	Benzyl alcohol.....	346
Propyl alcohol.....	813	Isopropyl alcohol.....	373
Isobutyl alcohol.....	498	Capryl alcohol.....	105
<i>act.</i> -Isoamyl alcohol.....	546	Trimethyl carbinol.....	94 ↑
Octyl alcohol.....	420	Dimethylethyl carbinol..	96 ↑

ETHER FORMATION FROM DIALKYL SULFATE IN ALCOHOLS (ROH) AS SOLVENT



Titrimetric method; first-order k for t in minutes, $k' = 0.4343k$; $\theta = 55^\circ\text{C}$ (314)

$\text{R}'_2\text{SO}_4$	ROH	$10^3k'$	Q_{10}
$(\text{CH}_3)_2\text{SO}_4$	CH_3OH	10.9	3.0
	$\text{C}_2\text{H}_5\text{OH}$	7.7	
	$\text{CH}_3(\text{CH}_2)_2\text{OH}$	6.0	
$(\text{C}_2\text{H}_5)_2\text{SO}_4$	CH_3OH	3.5	
	$\text{C}_2\text{H}_5\text{OH}$	2.15	2.1
	$\text{CH}_3(\text{CH}_2)_2\text{OH}$	1.9	

ESTER FORMATION FROM $(\text{CH}_3)_2\text{SO}_4$ IN CH_3OH AS SOLVENT

(a - x) (b - x) x

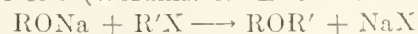
$$dx = k(a-x)(b-x)dt$$

Titrimetric method; second-order k for t in minutes and M/I (529)

MX	k , 0°	k , 12.6°	k , 25°	k , 40°
NaI.....	0.029	0.142	1.04	
NaCNS.....			0.196	0.804
KCNS.....			0.236	1.01

Reactivity of the Halogens in Organic Compounds

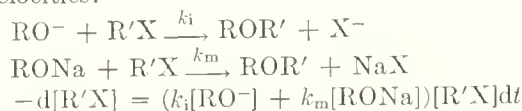
DOUBLE DECOMPOSITION OF ALCOHOLATES (RESP. PHENOLATES) WITH ALKYL HALIDES (RESP. CYANIDES) IN NON-AQUEOUS SOLUTIONS (WILLIAMSON ETHER SYNTHESIS)



a - x b - x x

$$\frac{dx}{dt} = k(a-x)(b-x)$$

The bimolecular constant varies with the dilution, V , in l/M, from which it follows that phenolate and phenolate ion react with different velocities:



or, if k_v is the bimolecular constant and α the degree of dissociation at the dilution, V :

$$\begin{aligned} k &= V k_v = k_i \alpha + k_m (1 - \alpha) \\ \frac{k}{V} &= k_v = \frac{a}{(b - a)t} \log_e \frac{a(b - x)}{b(a - x)} \end{aligned}$$

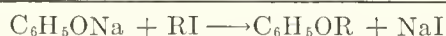
Titrimetric method; units: minutes and M/l; solvent, $\text{C}_2\text{H}_5\text{OH}$ (abs.) (0.01–0.03 % H_2O) (108); cf. (10, 11, 12, 14, 95, 354, 384, 426, 442, 493).

RONa	R'I	°C	k_i	k_m	$k_i:k_m$
$\text{C}_6\text{H}_5\text{ONa}$	CH_3I	25	0.0282	0.00474	5.95
		35	0.091	0.0131	6.74
$\text{C}_2\text{H}_5\text{ONa}$	$\text{C}_2\text{H}_5\text{I}$	25	0.127	0.0594	2.13
		25	0.0120	0.00472	2.81
		25	0.00576	0.00233	2.41
		25	0.1172	0.0976	1.14
		25	0.344	0.228	1.51
$\text{C}_8\text{H}_6\text{N}_3\text{OSNa}$	$\text{C}_2\text{H}_5\text{CN}$	25	0.4625	0.1579	2.90

k_i and k_m can be computed from any pair of values of k and V . For example, the following reaction of sodium 1-phenyl-3-thiourazol with $\text{C}_2\text{H}_5\text{I}$ at 25°C, yields:

$$k = 0.4625\alpha + 0.1579(1 - \alpha)$$

V	k , obs.	α	k , calc.
4	0.2265	0.248	0.2334
8	0.2575	0.334	0.2595
16	0.2895	0.421	0.2861
32	0.3120	0.514	0.3144
64	0.3350	0.607	0.3428



Titrimetric method; second-order k for t in minutes and M/l; $b = a = 0.2$; $\theta = 58.5^\circ\text{C}$; solvent, various alcohols; D = dielectric constant of solvent at 20° (439).

Solvent	k		D
	$\text{C}_2\text{H}_5\text{I}$	$\text{CH}_3(\text{CH}_2)_2\text{I}$	
Methyl alcohol.....	0.0276	0.0115	31.2
Ethyl alcohol.....	0.0622	0.0249	25.8
Propyl alcohol.....	0.0381	0.0161	22.2
Isobutyl alcohol.....	0.0187	0.00798	20.0
Isoamyl alcohol.....	0.01245	0.00540	16.0

Effect of alkyl radical and temperature; solvent, $\text{C}_2\text{H}_5\text{OH}$ (abs.); $b = a = 0.1$.

$$A' = \frac{T_1 T_2 (\log_{10} k_2 - \log_{10} k_1)}{T_2 - T_1}$$

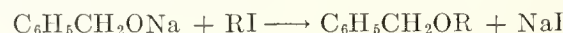
calculated from the values of k at 31.0 and 58.5°C.

R of RI	k , 31.0°	k , 42.5°*	k , 58.5°	k , 80.1°	A'
Methyl.....	0.0155	0.0607	0.326		4850
Ethyl.....	0.00342	0.0135	0.0710	0.510	4825
<i>n</i> -Propyl.....	0.00128	0.00520	0.0288	0.209	4922
<i>n</i> -Butyl.....	0.00127	0.00485	0.0267	0.197	4845
<i>n</i> -Amyl.....	0.000545	0.00210	0.0117	0.085	4887
<i>n</i> -Hexyl.....	0.00121	0.00464	0.0255	0.192	4825
<i>n</i> -Heptyl.....	0.00116	0.00451	0.0248	0.190	4874
<i>n</i> -Octyl.....	0.00109	0.00434	0.0242	0.187	4933
<i>n</i> -Hexadecyl.....	0.00107	0.00429	0.0236	0.184	4918
Isobutyl.....	0.000512	0.00193	0.0103	0.0700	4778
Isoamyl.....	0.000727	0.00285	0.0156	0.0760	4880

Effect of alkyl radical and temperature.—(Continued)

R of RI	k , 31.0°	k , 42.5°*	k , 58.5°	k , 80.1°	A'
Isopropyl.....	0.00123	0.00465	0.0259	0.193	4846
<i>sec</i> -Butyl.....	0.00132	0.00513	0.0277	0.205	4844
<i>sec</i> -Amyl.....	0.00120	0.00470	0.0260	0.197	4893
<i>sec</i> -Hexyl.....	0.00113	0.00433	0.0240	0.178	4866
<i>sec</i> -Heptyl.....	0.00110	0.00420	0.0230	0.170	4845
<i>sec</i> -Octyl.....	0.00107	0.00411	0.0226	0.168	4848
<i>tert</i> -Butyl†.....	0.0295	0.121			5100

* k for 42.5°C can be calculated from A' in good agreement with k , obs.
† k , 0° = 0.000 381 for $(\text{CH}_3)_3\text{CI}$.



Titrimetric method; units: minutes and M/l; solvent, $\text{C}_2\text{H}_5\text{OH}$ (abs.); $b = a = 0.1$ (244.5).* The equilibrium:

$\text{C}_6\text{H}_5\text{CH}_2\text{ONa} + \text{C}_2\text{H}_5\text{OH} \rightleftharpoons \text{C}_2\text{H}_5\text{ONa} + \text{C}_6\text{H}_5\text{CH}_2\text{OH}$ is reached very rapidly in this solvent with the result that the same k was found in both the following mixtures:

In $\text{C}_2\text{H}_5\text{OH}$ solution		k , 40°
0.1N $\text{C}_2\text{H}_5\text{I}$ + 0.1N $\text{C}_6\text{H}_5\text{CH}_2\text{ONa}$		0.04556
0.1N $\text{C}_2\text{H}_5\text{I}$ + 0.1N $\text{C}_2\text{H}_5\text{ONa}$ + 0.1N $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$		0.04560

* Contains citations from earlier literature.

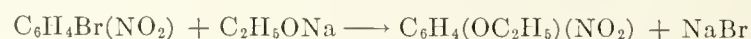
R of RI	$10^5 k$				A'
	30°	40°	50°	60°	
Methyl.....	15 950				4 510
Ethyl.....	1 423	4 556	13 690		4 793
<i>n</i> -Propyl.....	554.4	1 772	5 119	14 350	4 765
Isopropyl.....	331.0	1 035	3 053	8 175	4 695
<i>n</i> -Butyl.....	401.1	1 297	3 768	10 310	4 737
Isobutyl.....	520.7	1 637	4 890	12 790	4 683
Isoamyl.....	203.4	726	2 089	5 133	4 695
<i>sec</i> -Hexyl.....	576.8	1 830	5 407	14 595	4 731
<i>n</i> -Heptyl.....	400.7	1 297	3 776	10 160	4 716
<i>n</i> -Octyl.....	400.5	1 274	3 770	9 816	4 703
<i>sec</i> -Octyl.....	435.2	1 395	4 129	11 300	4 750
Hexadecyl.....	414.2	1 276	3 640	9 826	4 624

CH_3I , $10^5 k$	383.6(0°)	5147 (20°)
$\text{C}_2\text{H}_5\text{I}$, $10^5 k$		414.2(20°)

The relative constant, k , referred to any RI as unit is dependent upon T , since in the equation:

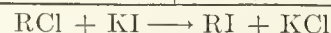
$$k = e^{-\frac{A}{T} + I} = e^I e^{-\frac{A}{T}} = k_0 e^{-\frac{A}{T}}$$

the A 's for various RI's are different. For $T = \infty$, $k = k_0$ is the limiting velocity. The relative limiting velocities are independent of T .



Titrimetric method; units: hours and M/l, $\theta = 50 \pm 0.1^\circ\text{C}$; $a = b = 0.02 - 0.025$ (416)

Bromide	k in $\text{C}_2\text{H}_5\text{OH}$	
	99.16 Vol. %	90.7 Vol. %
$\text{C}_6\text{H}_4\text{Br}(1)\text{NO}_2(2)$	0.0000627	0.0000271
$\text{C}_6\text{H}_4\text{Br}(1)\text{NO}_2(4)$	0.000122	0.0000820
$\text{C}_6\text{H}_4\text{Br}(1)\text{NO}_2(3)$	Very small	Very small



Titrimetric method; second-order k for hours and M/l, $k' = 0.4343k$; solvent, absolute acetone (124)

RCl	k' , 25°	k' , 50°*	k , 60°	A'
$\text{CH}_3(\text{CH}_2)_3\text{Cl}$		0.0415	0.119	4 920
$\text{CH}_3(\text{CH}_2)_4\text{Cl}$			0.128	
$\text{C}_6\text{H}_5\text{CH}_2\text{Cl}$	0.774	(9.83)		3 920
$\text{C}_6\text{H}_5(\text{CH}_2)_2\text{Cl}$		0.0466	0.108	3 920
$\text{C}_6\text{H}_5(\text{CH}_2)_3\text{Cl}$		0.0713	0.160	3 770

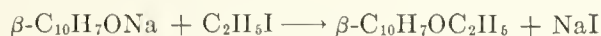
KCl + KI.—(Continued)

RCl	k' , 25°	k' , 50°*	k' , 60°	A'
C ₆ H ₅ (CH ₂) ₄ Cl.....		0.0617	0.1353	660
C ₆ H ₅ (CH ₂) ₅ Cl.....		(0.0590)	0.1293	660
C ₆ H ₅ (CH ₂) ₆ Cl.....		(0.0607)	0.1333	660
C ₆ H ₅ (CH ₂) ₇ Cl.....		(0.0580)	0.1273	660
ClCO ₂ C ₂ H ₅	0.0954	(1.74)		4 850
ClCH ₂ CO ₂ C ₂ H ₅	6.37	(116)		4 850
Cl(CH ₂) ₂ CO ₂ C ₂ H ₅		0.0667		
Cl(CH ₂) ₃ CO ₂ C ₂ H ₅		0.0686		
Cl(CH ₂) ₄ CO ₂ C ₂ H ₅		0.0562		
C ₆ H ₅ COCl.....		(90)		
C ₆ H ₅ COCH ₂ Cl.....		(12 600)		4 850
C ₆ H ₅ CO(CH ₂) ₂ Cl.....		3.60		4 850
C ₆ H ₅ CO(CH ₂) ₃ Cl.....		(15.4)		

* The values in parentheses are extrapolated.

Chloride.....	C ₆ H ₅ COCl	C ₆ H ₅ COCH ₂ Cl
k' , 0°.....	0.16	22.4

In homologous series, "alternating polarity" or the so-called "saw-tooth" rule is noted.



Titrimetric method; second-order k for t in minutes and M/l (127)

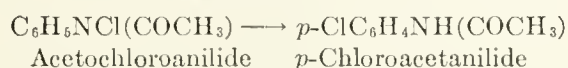
Solvent	k , 40.0°	k , 50.5°	k , 62.8°	Q_{10}	E
Ethyl alcohol.....	0.00790	0.0212	0.125	2.73	19 840
Isopropyl alcohol.....	0.00646	0.0177	0.101	2.75	19 990
Methyl alcohol.....	0.00460	0.0130	0.0875	2.89	21 010
<i>n</i> -Propyl alcohol.....	0.00442	0.0127	0.0868	2.93	21 300
<i>n</i> -Butyl alcohol.....	0.00404	0.0107	0.0631	2.70	19 650
Isobutyl alcohol.....	0.00399	0.0113	0.0525	2.70	19 650
Benzyl alcohol.....	0.00273	0.00781	0.0456	2.84	20 650
Isoamyl alcohol.....	0.00223	0.00649	0.0320	2.78	20 240
<i>tert</i> -Amyl alcohol.....	0.000533	0.00155	0.00987	2.92	21 190

Q_{10} is calculated from E for range 37.8-47.8°.

E is calculated from:

$$\log_e \frac{k_1}{k_2} = \frac{E}{1.985} \left(\frac{1}{T_2} - \frac{1}{T_1} \right).$$

REARRANGEMENT IN AQUEOUS SOLUTION

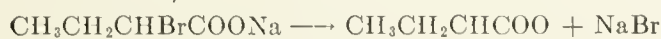


Titrimetric method; monomolecular k for t in minutes at 25°C is approximately proportional to $[\text{H}^+]^2$; effect of neutral salts (241)

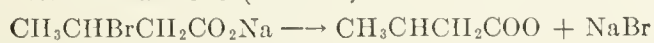
Salt, N	0.5	0.6	0.8	1.0	1.2	1.5
KCl, 10%.....	6.83	7.65	9.30	11.10	12.8	15.3
NaCl, 10%.....	6.92	7.80	9.65	11.75	13.6	16.9

There is a simple relation between the activity of Cl⁻ and the acceleration caused by neutral salts if the concentration of H₂O, C_w , does not appear in the velocity equation (240). For the effect of degree of hydration of Cl⁻, see (537, 538, 540). For kinetics of the reaction, see also (424).

Formation of Lactone from the Salts of Organic Halogen Acids
Titrimetric method; first-order k for t in minutes.



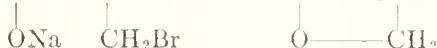
$k = 0.000021$ at 25°C (265, 266).



$k = 0.009$ at 38°C (280).



$k = 0.0024$ at 25° (267, 279).

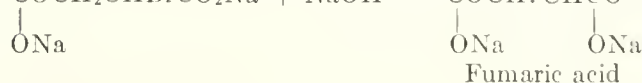
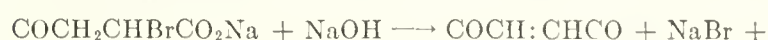


Itabromopyrotartaric acid \rightarrow Paraconic acid

$k = 0.0072$ at 0.05°C; $= 0.30$ at 25°C; $Q_{10} = 4.46$ (268).

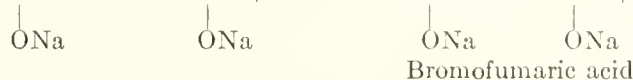
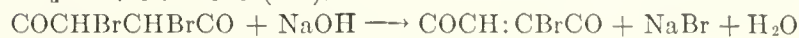
Acids retard lactone formation. The latter is accompanied by saponification of the lactone as a follow-reaction and by the formation of unsaturated organic acids and their saponification to hydroxy acids as side-reactions. Alkalies promote both of these effects.

Formation of Unsaturated Organic Acids from Halogen Acids
Titrimetric method; second-order k_a for alkaline saponification for t in minutes and M/l. The constant is greatly influenced by neutral salts.

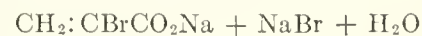


H₂O

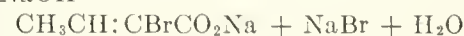
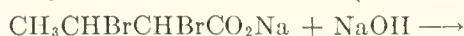
$k_a = 0.05$ at 25°C (279).



$k_a = 1.13$ at 19.4°C; $= 2.00$ at 25°C; $= 2.87$ at 30°C (264, 265, 266).



$k_a = 7.73$ to 9.27 at 25°C (264, 265, 266).



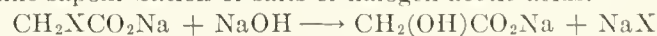
96.5% α -Bromocrotonic acid

3.5% α -Bromoalloctronic acid

$k_a = 0.134$ to 0.160 at 25°C (264, 265, 266).

For the barium salts, k_a is larger.

Saponification of Organic Halogen Acids to Hydroxy Acids
Alkaline saponification of salts of halogen acetic acids.

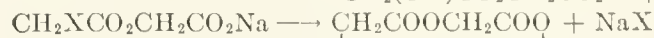
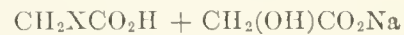
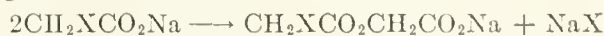


Titrimetric method; bimolecular k_a of alkaline saponification for t in minutes and M/l at 25°C (269, 279)

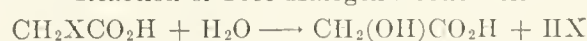
X	k_a	Lit.
Cl.....	0.00005	(279)
Br.....	0.0026	
I.....	0.0013	(269)

In neutral or acid solutions the saponification proceeds very slowly (167, 168, 440.5).

In concentrated solutions especially, it is accompanied by the following side- and follow-reactions (440.8):



Reaction of Free Halogen Acetic Acid



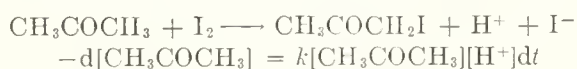
Titrimetric method; first-order k for t in minutes (168)

Acid	10 ⁶ k								
	40°	50°	60°	65°	70°	75°	80°	85°	90°
CH ₂ ClCO ₂ H.....				8.2	16	25	34	55	80
CH ₂ BrCO ₂ H.....	17	41	99						

For reaction of halogen acetic acids with KCNS and Na₂S₂O₃, see (147, 270, 310, 311).

The Action of Halogens on Organic Substances Containing Oxygen

ACTION OF IODINE ON ACETONE IN AQUEOUS SOLUTION



According to (138, 142, 331) the mechanism of the reaction is:



The enolization of acetone catalyzed by H^+ is the rate-determining reaction.

Weight-titrimetric method; units: minutes and M/l; catalyst, HCl ; M = accuracy of measurement in % (418)

$^{\circ}\text{C}$	0	24	25	27	35
10^4k	0.6994	15.187	17.148	21.609	52.840
M	0.10	0.20	0.070	0.14	0.10

Temp. interval, $^{\circ}\text{C}$	0-24	25-27	27-35
Q_{10}	3.605	3.181	3.057
A	20 669	20 540	20 528

The Arrhenius constant, A , shows a tendency to fall with rise of temperature.

Non-electrolytes change the value of k but not that of A ; for the effect of electrolytes on these constants, see (419). For acceleration of the reaction by various acids and its autocatalysis, see (138, 141).

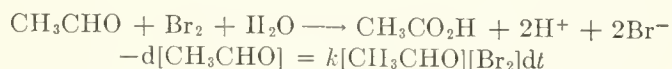
SAME REACTION WITH DIFFERENT KETONES IN 40% $\text{C}_2\text{H}_5\text{OH}$

Titrimetric method; first-order k for t in minutes; $\theta = 25^{\circ}\text{C}$; catalyst 0.2N H_2SO_4 (139, 142)

Ketone	10^4k	Ketone	10^4k
CH_3COCH_3	288	$\text{CH}_3\text{COC}_6\text{H}_5$	108
$\text{C}_2\text{H}_5\text{COC}_2\text{H}_5$	236	$\text{CH}_3\text{COCH}_2\text{C}_6\text{H}_5$	395
$\text{C}_3\text{H}_7\text{COC}_3\text{H}_7$	202	$\text{C}_2\text{H}_5\text{COC}_6\text{H}_5$	24
$\text{CH}_3\text{COC}_2\text{H}_5$	300	$p\text{-CH}_3\text{COC}_6\text{H}_4\text{Br}$	90
$\text{CH}_3\text{COC}_3\text{H}_7$	270	$p\text{-CH}_3\text{COC}_6\text{H}_4\text{I}$	90*
$\text{CH}_3\text{COCH}(\text{CH}_3)_2$	200	$p\text{-CH}_3\text{COC}_6\text{H}_4\text{NH}_2$	80
$\text{CH}_3\text{CO}(\text{CH}_2)_3\text{CH}_3$	318	$m\text{-CH}_3\text{COC}_6\text{H}_4\text{NO}_2$	45
$\text{CH}_3\text{COCH}_2\text{CH}(\text{CH}_3)_2$	247	$\text{CH}_2\text{BrCOC}_6\text{H}_5$	0
$\text{CH}_3\text{COC}(\text{CH}_3)_3$	132		
$\text{CH}_3\text{COC}_6\text{H}_{13}$	306		

* Solvent = 60 % $\text{C}_2\text{H}_5\text{OH}$.

OXIDATION OF ACETALDEHYDE BY BROMINE IN AQUEOUS SOLUTION



Titrimetric method; units: minutes and M/l (97, 140)

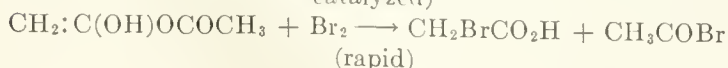
$^{\circ}\text{C}$	0	10	20	25	18
k	0.117	0.308	0.790	1.205	0.654
Q_{10}		2.64	2.55	2.33	

* The values at 18°C are from (140); all others from (97). For the side-reaction, see (140).

ACTION OF BROMINE ON ACETIC ANHYDRIDE USED AS ITS SOLVENT



Titrimetric method: $-dx = kdt$, where x = concn. of Br_2 ;
 $(\text{CH}_3\text{CO})_2\text{O} \xrightleftharpoons{\text{CH}_2\text{C}(\text{OH})\text{OCOCH}_3}$ (rate-determining, catalyzed)

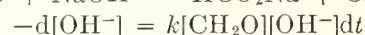
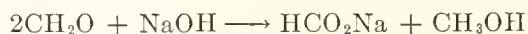


Units: minutes and g-atom Br/l ; C = concn. of catalyst in M/l; $\theta = 25^{\circ}\text{C}$ (393).

Catalyst	100C	100k	Catalyst	100C	100k
H_2SO_4	0.2	1.11	SnCl_4	0.097	0.77
	0.4	1.33		0.19	0.78
	0.8	2.23	SnBr_4	0.06	0.81
FeCl_3	0.06	1.39		0.12	0.96
	0.12	2.26		0.31	1.30
	0.24	4.20		0.50	1.60
	0.48	3.98	CH_3COCl	27	0.82
FeBr_3	0.065	3.38		54	0.50
HCl	2.72	0.96		81	0.62

Miscellaneous Organic Reactions

CANNIZZARO REACTION OF ALDEHYDES IN AQUEOUS SOLUTION

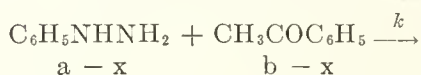


Titrimetric method; units: minutes and M/l (169); cf. (171, 407)

$^{\circ}\text{C}$	50	65	75	85
10^3k	5.5	30.2	93	294
Q_{10}		3.1	3.1	3.1

For reaction of $\text{C}_6\text{H}_5\text{CHO}$, see (407).

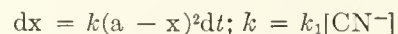
PHENYLHYDRAZONE FORMATION IN 95% ALCOHOL



Titrimetric method; second-order k for t in minutes and M/l; $\theta = 18^{\circ}\text{C}$ (53)

a	b	$[\text{HC}_2\text{H}_3\text{O}_2]$	$[\text{KC}_2\text{H}_3\text{O}_2]$	k
0.1	0.1	0.01	0.1	0.26
0.06	0.06	0.01	0.1	0.23
0.075	0.075	0.01	0.1	0.25
0.05	0.1	0.01	0.1	0.24
0.05	0.05	0.01	0.25	0.15

CN⁻ CATALYSIS OF THE BENZOIN SYNTHESIS

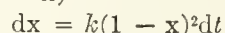
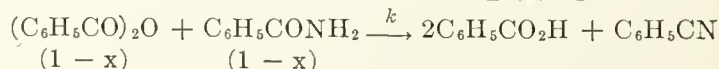


Gravimetric method; units: minutes and M/l (82, 500); solvent: 10 cm³ H_2O + 20 cm³ $\text{C}_2\text{H}_5\text{OH}$; $k_1 = 0.089$ (0.085 to 0.092) at 60°C ; $A = 6572$.

Effect of solvent at 60°C and $[\text{CN}^-] = 0.1$

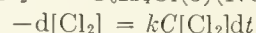
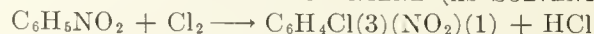
cm ³ H_2O	cm ³ $\text{C}_2\text{H}_5\text{OH}$	100k	cm ³ H_2O	cm ³ CH_3OH	100k
5	25	0.87	5	25	0.45
15	15	1.16	10	20	0.65
20	10	1.24	15	15	0.91

NITRILE FORMATION IN THE MELT



Method: temperature of primary crystallization of system.
 $(1 - x)[(\text{C}_6\text{H}_5\text{CO})_2\text{O} + \text{C}_6\text{H}_5\text{CONH}_2] +$
 $x[2\text{C}_6\text{H}_5\text{CO}_2\text{H} + \text{C}_6\text{H}_5\text{CN}]$
 $k = 0.053$ (0.050 to 0.055) at 98°C ; t in hours (318). For methods, see further (316, 317, 317.5, 318.5).

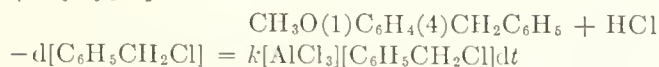
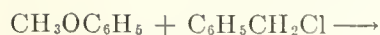
CHLORINATION OF NITROBENZENE (AS SOLVENT)



Titrimetric method; t in minutes; C = concn. of catalyst in M/l (213)

Catalyst	k, 50°	k, 100°	Q_{10}
SnCl_4	0.000778		
AlCl_3	0.0239	0.131	1.35

THE FRIEDEL-CRAFTS REACTION



Solvent, $\text{CH}_3\text{OC}_6\text{H}_5$; catalyst, AlCl_3 ; units: minutes and M/l;
 $k = 0.46$ at 0°C ; $= 2.0$ at 20°C (213); cf. (95.5, 488).

RELATIVE VELOCITY OF SULFONATION OF PHENOLS



If the velocity of sulfonation of phenol is taken as 1, then that for each of the three cresols is as follows (105):

$^\circ\text{C}$	20	40	60	80
<i>o</i> -Cresol.....	0.773	0.859	0.894	0.905
<i>m</i> -Cresol.....	1.395	1.362	1.118	0.399
<i>p</i> -Cresol.....	0.300	0.474	0.573	0.287

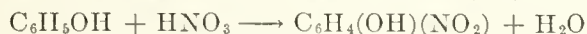
m-Cresol: *p*-Cresol = 1.059(100°).

m-Cresol: *m*-4-Xylenol = 3.020(40°); = 1.284(80°).

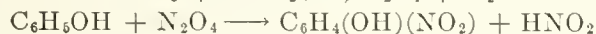
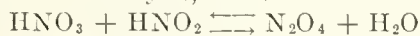
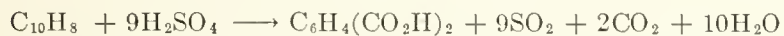
m-Cresol: *p*-Xylenol = 1.260(40°); = 1.297(80°).

These relationships are important in the separation of phenols in crude carbolic acid (355).

NITRATION OF AROMATIC SUBSTANCES (20); cf. (261, 301, 550)



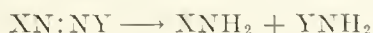
The reaction is autocatalytic, thus:

OXIDATION OF NAPHTHALENE TO PHTHALIC ACID BY MEANS OF H_2SO_4 

Gas-volumetric method; solvent, H_2SO_4 ; monomolecular k for t in minutes, $k' = 0.4343k$; mixture: 40 cm³ H_2SO_4 ; 0.0480 g C_{10}H_8 ; 0.28 g Hg_2SO_4 as catalyst (70, 94).

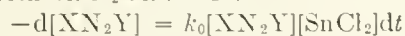
$^\circ\text{C}$	300	275	250	225
$10^5k'$, without catalyst....	ca. 178	21	2.2	
$10^5k'$, with catalyst.....	ca. 800	165	26	2.8

Slight amounts of water are without appreciable influence. CuSO_4 is a less satisfactory catalyst than Hg_2SO_4 ; the simultaneous action of both catalysts is more than additive. With increase of temperature, the uncatalyzed reaction gains the upper hand.

REDUCTION OF AZO COMPOUNDS BY SnCl_2 IN AQUEOUS HCl (RESP. BY SnBr_2 IN AQUEOUS HBr)

Colorimetric method; units: minutes and M/l; $\theta = 25^\circ\text{C}$ (205)

Reduction with SnCl_2 and HCl :



$$k_0 = k[\text{H}^+][\text{Cl}^-]^2$$

$$k_0 = k_1[\text{Cl}^-] + k_2[\text{H}^+][\text{Cl}^-]^2$$

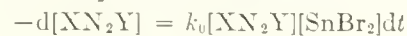
$$k_0 = k_3[\text{Cl}^-]$$

$$k_0 = k_4 + k_5[\text{Cl}^-]$$

XN_2Y	k	k_1	$10^{-2}k_2$	k_3	k_4	k_5
Azobenzenetrimethylammonium chloride.....	991					
Azobenzene- <i>m,m'</i> -disulfonic acid.....	175					
<i>p</i> -Dimethylaminoazobenzene.....	368					
<i>p</i> -Diethylaminoazobenzene....	955					
<i>p</i> -Aminoazobenzene.....	726					
Methyl orange.....	69.5					
β -Naphthylaminoazobenzenesulfonic acid.....	260	66.2				
Benzeneazo- α -naphthylamine-4, 7-disulfonic acid.....	596	134.7				
Naphthionic acid-azobenzenesulfonic acid.....	506	329.3				

Reduction with SnCl_2 .—(Continued)

XN_2Y	k	k_1	$10^{-2}k_2$	k_3	k_4	k_5
Chrysoidin T.....		7.5	5.2			
<i>p</i> -Hydroxyazobenzene.....		4.4	1.4			
Tropäolin Y.....	521					
α -Naphthol orange.....		99.6	0.9			
β -Naphthol orange.....				25.8		
Ponceau 4GB.....					1.8	23.9
Ponceau G.....					6.7	10.7
Ponceau 2R.....					1.15	1.45

Reduction with SnBr_2 and HBr :

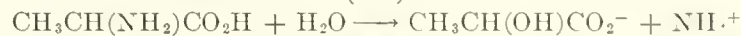
$$k_0 = k[\text{Br}^-]^3$$

$$k_0 = k_1[\text{H}^+][\text{Br}^-]^2$$

$$k_0 = k_2 + k_3[\text{Br}^-]$$

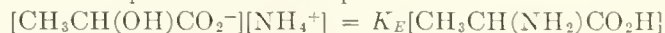
XN_2Y	$10^{-2}k$	$10^{-2}k_1$	k_2	k_3
<i>m,m'</i> -Azobenzenedisulfonic acid.....	12.1			
Dimethylaminoazobenzene.....		9.48		
Diethylaminoazobenzene.....		23.9		
Benzeneazo- β -naphthol-3, 6-disulfonic acid.....			30	157

For the reduction of nitro compounds by SnCl_2 , see (202, 210, 219, 302).

HYDROLYSIS OF AMINO ACIDS IN AQUEOUS SOLUTION AT 100°C (561)

The reaction takes place only with animal charcoal as catalyst. No hydrolysis is observed in the absence of catalyst.

The reaction proceeds to the equilibrium:



But the kinetics of the process corresponds to a reaction without reversal:

$$dx = k(a - \xi - x)dt.$$

$$k = \frac{1}{t} \log_e \frac{a - \xi}{a - \xi - x} \text{ for } t \text{ in minutes.}$$

$$k' = 0.4343k.$$

a = initial concentration of amino acid in M/l.

ξ = equilibrium concentration, or, more exactly, concentration of amino acid at the end of the reaction.

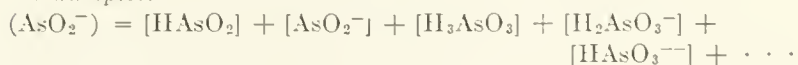
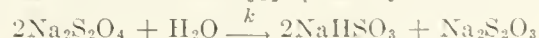
Alanine			Aspartic acid		
a	$1:K_E$	$100k'$	a	$1:K_E$	$100k'$
0.0422	56.8	6.4 - 5.3	0.0315	18.5	3.9 - 5.4
0.080	73.5	7.1 - 5.8	0.0593	15.4	6.7 - 6.5
0.116	77.0	7.6 - 6.1	0.0795	17.9	7.3 - 6.9

For further examples of one-sided equilibria and for the theory, see (32, 565).

Inorganic Oxidation-Reduction Reactions

The symbols in square brackets denote concentration in M/l, in parentheses, the analytic or total concentration in M/l.

Examples:

DECOMPOSITION OF $\text{Na}_2\text{S}_2\text{O}_4$ IN AQUEOUS SOLUTION

$$a - x \quad c = \text{constant}$$

$$dx/dt = kc^2(a - x)^2$$

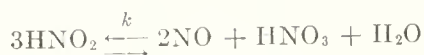
Titrimetric method; t in minutes; c and a in g/100 g soln.; values of kc^2 for $c = 15$ (278.5).

$^\circ\text{C}$	0	10	20	30
10^4kc^2	1.4	2.3	3.7	6.3

$$Q_{10}(0 - 30^\circ) = 1.65.$$

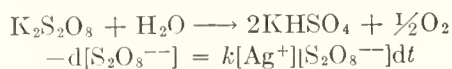
$$\text{Recalculated to M/l: } -d(\text{Na}_2\text{S}_2\text{O}_4) = 0.003(\text{NaHSO}_3)^2 \times (\text{Na}_2\text{S}_2\text{O}_4)^2 dt (20^\circ).$$

DECOMPOSITION OF NITROUS ACID IN AQUEOUS SOLUTION



Titrimetric method; first-order k for t in minutes; R = velocity in liters per minute of the inert gases (N_2 , H_2) which are bubbled through the solution (302.5). The process defining the velocity is the escape of NO from the system. For more recent data, *v.* (8.5, 564).

$^{\circ}\text{C}$	15	15	15	15	30	30
R	0.56	0.93	0.56	0.77	0.03	0.77
$[\text{HNO}_3]$	1.185	1.185	3.626	3.626	3.626	3.626
$100k$	3.7	4.5	5.0	8.0	1.2	1.0

CATALYTIC DECOMPOSITION OF $\text{K}_2\text{S}_2\text{O}_8$ AT 18°C IN AQUEOUS SOLUTION CATALYZED BY AgNO_3 

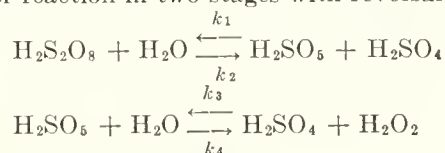
Titrimetric method; t in minutes (253).

$[\text{Ag}^+]$	$k[\text{Ag}^+]$	k
0.004	0.00079	0.20
0.01	0.00210	0.21
0.02	0.00375	0.19

Mean $k = 0.20$.

DECOMPOSITION OF $\text{H}_2\text{S}_2\text{O}_8$ IN AQUEOUS SOLUTION OF H_2SO_4 AT 50°C

A first-order reaction in two stages with reversal:



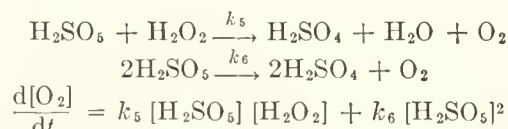
$(\text{H}_2\text{SO}_4) = \text{constant}$

Titrimetric method; t in seconds (397).

(H_2SO_4)	$100k_1$	$1000k_3$	10^5k_4	$k_1:k_3$	$k_1:(\text{H}_2\text{SO}_4)$
5.00	8.758	2.244	4.5	39.0	0.01752
3.76	3.026	0.760		39.8	0.00804
2.50	1.043	0.262		39.8	0.00418

k_2 is measurable only at very high (H_2SO_4) . For the above computations of k_1 and k_3 , k_2 and k_4 were taken as zero.

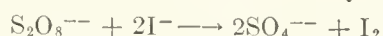
To a slight extent the following simultaneous reactions take place:



(H_2SO_4)	10^6k_5	10^7k_6
5.00	4.3	9
3.76	8.9	9
2.50	53.0	112

The loss of active oxygen through evolution of O_2 increases greatly with decreasing (H_2SO_4) . For strongly acid solution it is negligible.

ACTION OF PERSULFATE ON IODINE IN AQUEOUS SOLUTION



Titrimetric method; t in minutes (409).

$$-d[\text{S}_2\text{O}_8^{--}] = 0.16[\text{S}_2\text{O}_8^{--}][\text{I}^-]dt \text{ at } 25^{\circ}\text{C}$$

OXIDATION OF THIOSULFATE BY H_2O_2 IN AQUEOUS SOLUTION WITH AND WITHOUT CATALYST

Titrimetric method; solvent, acetic acid; t in minutes (2, 2.5).

Catalyst, I^-

$$\frac{-d[\text{H}_2\text{O}_2]}{dt} = 1.53[\text{H}_2\text{O}_2][\text{S}_2\text{O}_3^{--}] + 0.7[\text{I}^-][\text{H}_2\text{O}_2] \text{ at } 25^{\circ}\text{C}$$

Catalyst, Cu^{++}

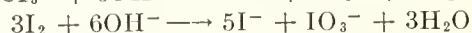
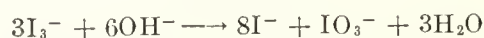
$$\frac{-d[\text{H}_2\text{O}_2]}{dt} = 1.53[\text{H}_2\text{O}_2][\text{S}_2\text{O}_3^{--}] + 1.0 \times 10^3[\text{Cu}^{++}][\text{H}_2\text{O}_2] \text{ at } 25^{\circ}\text{C}$$

$$4\text{H}_2\text{O}_2 + \text{S}_2\text{O}_3^{--} \longrightarrow 2\text{SO}_4^{--} + 2\text{H}^+ + 3\text{H}_2\text{O} \quad (6)$$

Catalyst, molybdc acid

$$\frac{-d[\text{H}_2\text{O}_2]}{dt} = \left\{ 0.75 \times 10^3 + 1.75 \times 10^7[\text{H}^+] \right\} [\text{S}_2\text{O}_3^{--}](\text{MoO}_3) \text{ at } 25^{\circ}\text{C}$$

FORMATION OF IODATE FROM IODINE IN AQUEOUS ALKALINE SOLUTION



Titrimetric method; t in minutes; $\theta = 25^{\circ}\text{C}$ (445, 446, 447, 464).

For the *rapid* reaction:

$$\frac{-d[\text{I}_3^-]}{dt} = 2.0 \frac{[\text{OH}^-][\text{I}_3^-]^2}{[\text{I}^-]^3} \quad (\text{I})$$

For the *slow* iodate formation:

$$\frac{-d[\text{I}_3^-]}{dt} = 2.3 \times 10^{11} \frac{[\text{OH}^-]^4[\text{I}_3^-]^3}{[\text{I}^-]^6} \quad (\text{II})$$

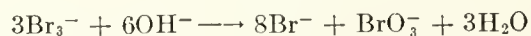
$$\frac{-d[\text{I}_2]}{dt} = 4.1 \times 10^{19} \frac{[\text{OH}^-]^4[\text{I}_2]^3}{[\text{I}^-]^3} \quad (\text{III})$$

Values of Q_{10} for I, II, III in various buffer solutions

	Q_{10}			
	NaOH	$\text{Na}_2\text{CO}_3/\text{NaHCO}_3$	$\text{Na}_2\text{HPO}_4/\text{NaH}_2\text{PO}_4$	NaAc/HAc^*
I	3	6		
II	3.6	45		ca. 100
III			50	

* Ac = Acetate radical.

FORMATION OF BROMATE FROM BROMINE IN AQUEOUS ALKALINE SOLUTION



Titrimetric method; t in minutes; $\theta = 25^{\circ}\text{C}$ (483).

For the *rapid* bromate formation:

$$\frac{-d[\text{Br}_3^-]}{dt} = 6.5 \times 10^4 \frac{[\text{OH}^-][\text{Br}^-]^2}{[\text{Br}^-]^3}$$

For the *slow* reaction:

$$\frac{-d[\text{Br}_3^-]}{dt} = 3.8 \times 10^{22} \frac{[\text{OH}^-]^4[\text{Br}^-]^3}{[\text{Br}^-]^7}$$

FORMATION OF HALOGENATE IN AQUEOUS SOLUTION OF HYPOHALOGENITE AND HYPOHALOGENOUS ACIDS

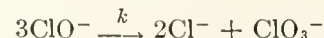


Titrimetric method (179, 181, 319); steady state in electrolysis of NaCl (374.5); *cf.* (180, 303, 486).

$$-d[\text{XO}^-] = k[\text{XO}^-][\text{HXO}]^2dt; t \text{ in minutes}$$

XO^-	k , 15°	k , 25°
ClO^-	1.12 (374.5)	1.6 (179)
BrO^-		170 (319)

DECOMPOSITION OF HYPOCHLORITE IN STRONGLY ALKALINE SOLUTION



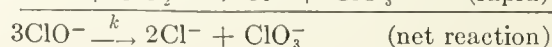
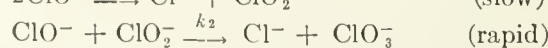
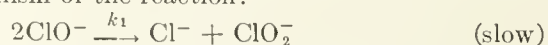
Titrimetric method; bimolecular k ; t in days (149.5, 180).

$$\frac{-d[\text{ClO}^-]}{dt} = k[\text{ClO}^-]^2$$

(NaOH)	0.1	0.5	2.0
k , 25°	0.0022	0.0023	0.0028*
k , 50°	0.0455	0.0512	0.08 \uparrow *
k , 90°	4.9*		

* The reaction proceeds with O_2 -evolution as a simultaneous reaction.

Mechanism of the reaction:



Values of bimolecular k_1 and k_2 for 0.1N NaOH; t in hours

°C.	25	50	Q_{10}
k_1	0.00010	0.0019	3.16
k_2	0.0035	0.050	2.88

For this reaction and the analogous hypobromite reaction, see (112, 198).

DECOMPOSITION OF HYPOBROMITE IN Na_2CO_3 AND NaHCO_3 SOLUTION (445)



Titrimetric method; t in minutes; $\theta = 25^\circ$

$$\frac{-d(\text{NaBrO})}{dt} = 2 \times 10^{-4} \frac{[\text{Br}^-](\text{NaBrO})^2}{[\text{OH}^-]}$$

DECOMPOSITION OF HYPOIODITE IN STRONGLY ALKALINE SOLUTION



Titrimetric method; t in minutes; $\theta = 25^\circ\text{C}$ (444, 445, 446, 466); cf. (96, 118, 182, 339, 404, 438).

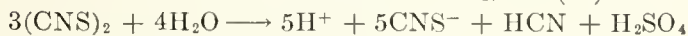
For solution rich in I^- :

$$\frac{-d(\text{NaIO})}{dt} = 87 \frac{[\text{I}^-](\text{NaIO})^2}{[\text{OH}^-]}; \quad Q_{10} = 2.1$$

For solution poor in I^- :

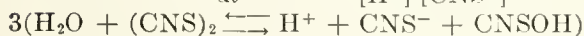
$$\frac{-d(\text{NaIO})}{dt} = 2 \frac{(\text{NaIO})^2}{[\text{OH}^-]}; \quad Q_{10} = 2.5$$

HYDROLYSIS OF FREE THIOCYANATE (48)

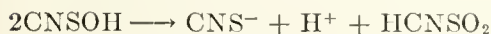


Titrimetric method; t in minutes; $\theta = 18^\circ\text{C}$.

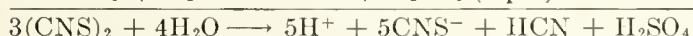
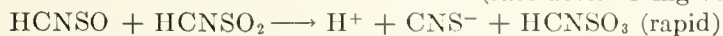
$$\frac{-d[(\text{CNS})_2]}{dt} = 5 \frac{[(\text{CNS})_2]^2}{[\text{H}^+]^2[\text{CNS}^-]^2}; \quad Q_{10} = 2.84$$



(preliminary equilibrium)

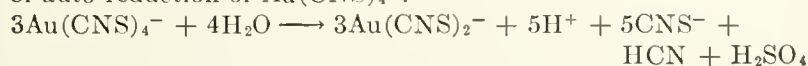


(rate-determining velocity)

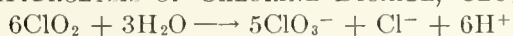


(net reaction)

The hydrolysis of free thiocyanate determines also the velocity of auto-reduction of $\text{Au}(\text{CNS})_4^-$:



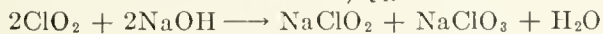
HYDROLYSIS OF CHLORINE DIOXIDE, ClO_2



Titrimetric method; t in minutes (63, 64).

$$\frac{-d[\text{ClO}_2]}{dt} = k[\text{ClO}_2]^2[\text{Cl}^-] + k_1[\text{ClO}_2]^2[\text{Cl}^-][\text{H}^+]$$

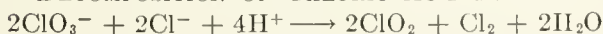
$$k = 0.056 \text{ at } 60^\circ\text{C}; \quad Q_{10} = 2.25$$



$$\frac{-d[\text{ClO}_2]}{dt} = k[\text{ClO}_2]^2[\text{OH}^-]$$

$$k = 300 \text{ at } 0^\circ\text{C}; = 950 \text{ at } 19^\circ\text{C}; \quad Q_{10} = 1.8$$

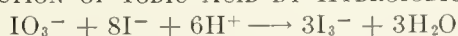
DECOMPOSITION OF CHLORIC ACID BY HCl



Method: Removal of reaction products by a stream of inert gas; t in minutes; $\theta = 50^\circ\text{C}$ (348).

$$-d[\text{ClO}_3^-] = 0.001[\text{ClO}_3^-]^2[\text{Cl}^-]^2[\text{H}^+]^4 dt$$

REDUCTION OF IODIC ACID BY HYDROIODIC ACID



Titrimetric method; t in minutes (159).

$$\frac{-d[\text{IO}_3^-]}{dt} = k_1[\text{IO}_3^-][\text{I}^-]^2[\text{I}^-]^{1.9} + k_2[\text{IO}_3^-][\text{H}^+]^2[\text{I}^-][\text{I}_3^-]$$

H^+ buffer: acetic acid + acetate

°C.	0	14	37	0*
$10^{-10}k_1$	2.54	3.90	5.90	0.84
$10^{-10}k_2$	1.70			0.32

* These values at 0°C were obtained in mineral acid solution.

At $\theta = 25^\circ$, $k_1 = 5.33 \times 10^{10}$ (432); $= 5.29 \times 10^{10}$ (447).

$$\frac{-d[\text{IO}_3^-]}{dt} = [\text{IO}_3^-][\text{I}^-][\text{I}^-]^{1.9} \{7.6[\text{I}^-] + 5.5[\text{I}_3^-]\} \times 10^{10} \text{F at } 25^\circ\text{C}$$

$$\text{F} = 10^{-2.20\sqrt{\text{I}}} \text{ for } \text{H}_2\text{SO}_4 \text{ solution.}$$

$$\text{F} = 10^{-0.20\sqrt{\text{I}+0.50\text{I}}} \text{ for } \text{CH}_3\text{CO}_2\text{H} \text{ solution.}$$

Where $\text{I} = \sum_i \text{C}_i \text{Z}_i^2 =$ ion concentration according to the theory of (9).

REDUCTION OF HALOGENATE BY HALIDE IN ACID SOLUTION, WITH OR WITHOUT REMOVAL OF THE REACTION PRODUCTS BY MEANS OF H_3AsO_3 OR H_2SO_3

Titrimetric method or simultaneous kinetics of the Landolt reaction; t in minutes; $\theta = 25^\circ\text{C}$.

$$\frac{-d[\text{XO}_3^-]}{dt} = \text{Kf}(c); \quad \text{X} = \text{Cl, Br, I}$$

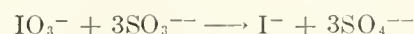
No.	f(c)	K	Q_{10}	Lit.
1	$[\text{IO}_3^-][\text{H}^+]^2[\text{I}^-]^2$	5300×10^7	1.25	(159, 447, 448)
2	$[\text{IO}_3^-][\text{H}^+]^2[\text{I}^-][\text{Br}^-]$	600×10^7 *		(475)
3	$[\text{IO}_3^-][\text{H}^+]^2[\text{I}^-][\text{Cl}^-]$	6×10^7 *		
4	$[\text{IO}_3^-][\text{H}^+]^2[\text{Br}^-]^2$	6600 *		
5	$[\text{IO}_3^-][\text{H}^+]^2[\text{Br}^-][\text{Cl}^-]$	6000 *		
6	$[\text{IO}_3^-][\text{H}^+]^2[\text{Cl}^-]^2$	600 *		
7	$[\text{BrO}_3^-][\text{H}^+]^2[\text{I}^-]$	4900	1.9	(113, 385)
8	$[\text{BrO}_3^-][\text{H}^+]^2[\text{Br}^-]$	200	2.0	(34, 286, 482)
9	$[\text{BrO}_3^-][\text{H}^+]^2[\text{Cl}^-]$	30		(482)
10	$[\text{ClO}_3^-][\text{H}^+]^2[\text{I}^-]$	0.0008	2.6	(61, 64)
11	$[\text{ClO}_3^-][\text{H}^+]^2[\text{Br}^-]$	0.0005†		
12	$[\text{ClO}_3^-][\text{H}^+]^2[\text{Cl}^-]$	0.0001‡	2.7	(61, 64)

* At room temperature.

† Interpolated.

‡ Products removed by I^- .

REDUCTION OF IODIC ACID BY SULFUROUS ACID

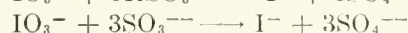
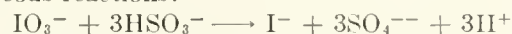


The reaction is the initial step of the Landolt reaction; cf. (162, 163, 330.5, 486, 510, 511).

For the region of $[\text{H}^+] = 10^{-3}$ with t in seconds and $\theta = 16^\circ\text{C}$ (455):

$$\frac{-d[\text{IO}_3^-]}{dt} = 0.34 \times 10^3 (\text{SO}_3^{--})[\text{IO}_3^-][\text{H}^+]; \quad Q_{10} = 1.3$$

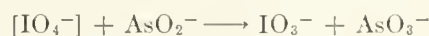
Simultaneous reactions:



In the range $[\text{H}^+] = 10^{-4}$ to 10^{-13} , for t in minutes at 25°C (486) the rate law is:

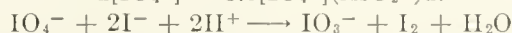
$$\frac{-d[\text{IO}_3^-]}{dt} = 0.53 \times 10^6 [\text{H}^+][\text{HSO}_3^-][\text{IO}_3^-] + 0.67 \times 10^{17} [\text{H}^+]^2 [\text{SO}_3^{--}]^2 [\text{IO}_3^-]$$

REDUCTION OF PERIODATE IN ACETIC ACID SOLUTION



Titrimetric method; t in minutes; $\theta = 25^\circ\text{C}$ (7).

$$-d[\text{IO}_4^-] = 5.5[\text{IO}_4^-](\text{AsO}_2^-)dt$$

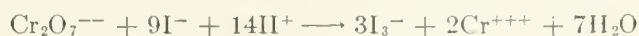


Acetic acid-acetate buffer; measured quantities of HAsO_2 present; method depended upon determination of time of first appearance of iodine color; for t in minutes at 25°C (8).

$$-d[\text{IO}_4^-] = k[\text{IO}_4^-][\text{I}^-]dt$$

$k = 380$ to 545 according to the salt content.

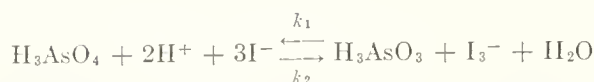
REDUCTION OF POTASSIUM DICHROMATE BY HYDROIODIC ACID



Titrimetric method; t in minutes; $\theta = 0^\circ\text{C}$ (146, 199, 252).

$$\frac{-d[\text{I}_3^-]}{dt} = 10^3 (\text{Cr}_2\text{O}_7^{--})[\text{H}^+]^2[\text{I}^-] + 0.25 \times 10^3 (\text{Cr}_2\text{O}_7^{--})[\text{H}^+][\text{I}^-]^2; \quad Q_{10} = 1.4.$$

REDUCTION OF ARSENIC ACID BY HYDROIODIC ACID AND THE REVERSE REACTION



Titrimetric method; t in minutes; $\theta = 0^\circ\text{C}$ (427.5); cf. (58, 62); for the determination of the equilibrium constant at 25°C , v. (539).

$$\frac{d[\text{I}_3^-]}{dt} = k_1(\text{H}_3\text{AsO}_4)[\text{I}^-][\text{H}^+] - k_2 \frac{(\text{H}_3\text{AsO}_3)[\text{I}_3^-]}{[\text{I}^-]^2[\text{H}^+]}$$

$$k_1 = 3 \times 10^{-3}; Q_{10} = 2.2.$$

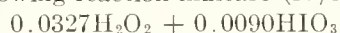
$$k_2 = 4.7 \times 10^{-4}; Q_{10} = 3.5.$$

The equilibrium constant, K , for 0°C then becomes:

$$\frac{(\text{H}_3\text{AsO}_4)[\text{I}^-]^3[\text{H}^+]^2}{(\text{H}_3\text{AsO}_3)[\text{I}_3^-]} = \frac{k_2}{k_1} = K = 0.16$$

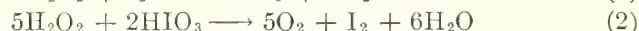
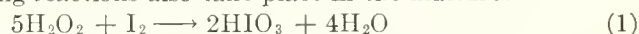
A PERIODIC REACTION IN HOMOGENEOUS SOLUTION (65); cf. (315, 342)

The periodicity refers to the iodine determined by colorimetric method in the following reaction mixture (M/l) at 25°C :



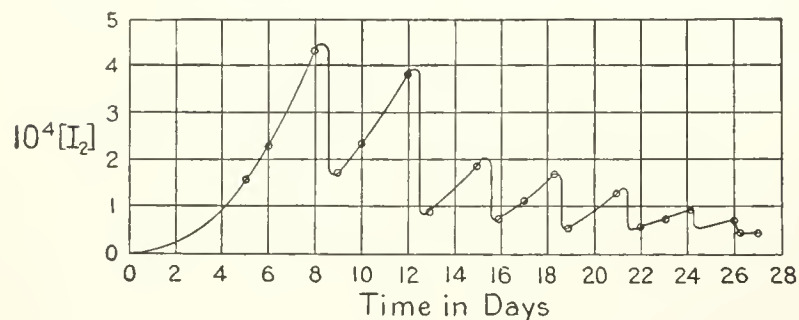
After 29 days the concentration of H_2O_2 had decreased to about 93%; see figure below.

The following reactions also take place in the mixture:



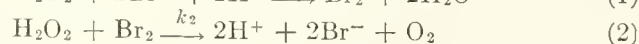
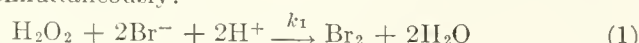
Reactions (1) and (2) catalyze (3).

The periodic evolution of oxygen was demonstrated at 60°C in a narrow range of H^+ concentrations.

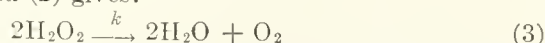


A REACTION WITH A STEADY STATE

Aqueous solution of H_2O_2 , Br_2 , Br^- in $0.2N \text{H}_2\text{SO}_4$; titrimetric method; units: minutes and M/l; $\theta = 25^\circ\text{C}$ (66, 66.5, 111, 341); cf. (342). Simultaneously:



Addition of (1) and (2) gives:



Reaction (1) and (2) proceed independently of each other. If their velocities are equal, $[\text{Br}^-]$, $[\text{Br}_2]$ and $[\text{H}^+]$ are constant, and therefore independent of time, and the net result is only the velocity of (3). Measurement in this steady state gives:

$$\left. \begin{aligned} \frac{-d[\text{H}_2\text{O}_2]}{dt} &= k[\text{H}_2\text{O}_2][\text{H}^+][\text{Br}^-] \\ k &= 0.0140 \end{aligned} \right\} \quad (4)$$

In the steady state, moreover, the following relation holds:

$$\frac{\text{Br}_2}{[\text{H}^+]^2[\text{Br}^-]^2} = R = 0.20 \quad (5)$$

The time law for the simultaneous reactions (1) and (2) is:

$$\frac{-d[\text{H}_2\text{O}_2]}{dt} = k_1[\text{H}_2\text{O}_2][\text{H}^+][\text{Br}^-] + k_2 \frac{[\text{H}_2\text{O}_2][\text{Br}_2]}{[\text{H}^+][\text{Br}^-]} \quad (6)$$

$$\frac{d[\text{Br}_2]}{dt} = k_1[\text{H}_2\text{O}_2][\text{H}^+][\text{Br}^-] - k_2 \frac{[\text{H}_2\text{O}_2][\text{Br}_2]}{[\text{H}^+][\text{Br}^-]} \quad (7)$$

With the numerical values:

$$\left. \begin{aligned} k_1 &= 0.0074 \\ k_2 &= 0.035 \end{aligned} \right\} \quad (8)$$

Addition of (6) and (7) gives:

$$\frac{-d[\text{H}_2\text{O}_2]}{dt} + \frac{d[\text{Br}_2]}{dt} = 2k_1[\text{H}_2\text{O}_2][\text{H}^+][\text{Br}^-] \quad (9)$$

or, for the steady state:

$$\left. \begin{aligned} \frac{d[\text{Br}_2]}{dt} &= 0 \\ \frac{-d[\text{H}_2\text{O}_2]}{dt} &= 2k_1[\text{H}_2\text{O}_2][\text{H}^+][\text{Br}^-] \end{aligned} \right\} \quad (10)$$

From (10) and (4) it follows that:

$$k = 2k_1 = 2 \times 0.0074 = 0.0148 \quad (11)$$

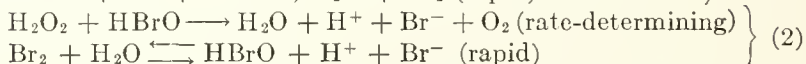
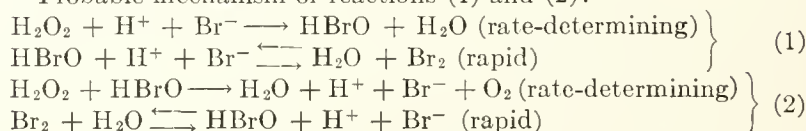
in satisfactory agreement with the directly measured value, $k = 0.014$.

It further follows from (7) for the steady state:

$$\frac{[\text{Br}_2]}{[\text{H}^+]^2[\text{Br}^-]^2} = \frac{k_1}{k_2} = \frac{0.0074}{0.035} = 0.21 = R \quad (12)$$

in agreement with the observed value, $R = 0.20$.

Probable mechanism of reactions (1) and (2):



LITERATURE

(For a key to the periodicals see end of volume)

- (1) Abel, in Ulzer and Klimont, *Allgemeine und physiologische Chemie der Fette*. Berlin, Springer, 1906. (2) Abel, 9, 13: 555; 07. (2.5) Abel, 57, 28: 1239; 07. 34: 1361; 13. (3) Abel, 9, 14: 598; 08. (4) Abel, 57, 34: 821; 13. (5) Abel, 7, 96: 1; 20. 57, 41: 405; 20. (6) Abel and Baum, 57, 34: 425; 13. (7) Abel and Fürth, 7, 107: 305; 23. (8) Abel and Fürth, 7, 107: 313; 23. (8.5) Abel and Schmid, 7, 132: 55; 28. 134: 279; 28. 136: 135; 28. (9) Abel and Stadler, 7, 122: 49; 26.
- (10) Acree, 11, 48: 352; 12. (11) Acree, 1, 37: 1909; 15. (12) Acree and Johnson, 11, 37: 410; 07. 38: 258; 07. (13) Acree and Nirdlinger, 11, 38: 489; 07. (14) Acree and Shadinger, 11, 39: 226; 08. (15) Adams and Rosenstein, 1, 36: 1452; 14. (16) Adkins, 1, 44: 2175; 22. (17) Adkins and Nissen, 1, 45: 809; 23. (18) Åkerlöf, 7, 98: 260; 21. (19) von Antropoff, 52, 77: 273; 08.
- (20) Arnall, 4, 123: 3111; 23. (21) Arrhenius, 7, 1: 110; 87. (22) Arrhenius, 7, 11: 805; 93. (23) Arrhenius, 7, 28: 317; 99. (24) Arrhenius, 9, 30: 375; 24. (25) Atkins and Werner, 4, 101: 1167, 1982; 12. (26) Auerbach and Pick, 291, 38: 243; 11. (27) Baker, 4, 77: 646; 00. 121: 568; 22. 135, 99: 126; 09. (28) Baker and Baker, 4, 91: 1862; 07. 101: 2339; 12. (29) Baker, Ingold and Thorpe, 4, 125: 268; 24.
- (30) Balcom, *Diss.*, Heidelberg, 1905. (31) Bauer and Moser, 25, 40: 918; 07. (32) Baur, 7, 112: 199; 24. (33) Beckmann, 25, 42: 846; 09. (34) Bell, 50, 7: 61; 03. (35) Bernoulli and Jakubowicz, 37, 4: 1018; 21. (36) Bernoulli and Wege, 37, 2: 511; 19. (37) Berthelot and Péan de St. Gilles, 6, 65: 385; 62. 66: 5; 62. 68: 225; 63. (38) Biddle, 1, 35: 273; 13. 36: 84; 14. (39) Biddle, 1, 37: 2088; 15. 38: 901; 16.
- (40) Biddle and Brauer, 1, 37: 2065; 15. (41) Biddle, Brauer and Kelly, 1, 34: 500; 12. (42) Biddle and Butzbach, 1, 37: 2082; 15. (43) Biddle and Porter, 1, 37: 1571; 15. (44) Biddle and Rosenstein, 1, 35: 418; 13. (45) Bigelow, 7, 26: 493; 98. (46) Bjerrum, 7, 59: 336, 581; 07. 73: 724; 10. (47) Bjerrum, 93, 118: 131; 21. (48) Bjerrum and Kirschner, 214, 5: No. 1; 18. (49) Bodenstein, 25, 26: 1146, 2603; 93. 7, 13: 56; 94. 22: 1; 97. 29: 295; 99.
- (50) Bodenstein, 9, 24: 183, 381; 18. 7, 100: 68; 22. (51) Bodenstein, 7, 104: 51; 23. (52) Bodenstein and Lind, 7, 57: 168; 05. (53) Bodfors, 7, 109: 223; 24. (54) Böeseken, Brandsma and Schoutissen, 64P, 23: 249; 22. (55) Böeseken and Couvert, 70, 40: 354; 21. (56) Böeseken, Schweizer and van der Want, 70, 31: 86; 12. (57) Böttger and Kötze, 52, 65: 481; 02. (58) Bowman, 50, 11: 292; 07. (59) Boyd and Marle, 4, 105: 2117; 14.
- (60) Boyd and Thomas, 4, 115: 1239; 19. (61) Bray, 50, 7: 92; 03. (62) Bray, 50, 9: 573; 05. (63) Bray, 93, 48: 217; 06. (64) Bray, 7, 54: 463; 06. (65) Bray, 1, 43: 1262; 21. (66) Bray and Livingston, 1, 45: 1251; 23. (66.5) Bray and Livingston, 1, 50: 1654; 28. (67) Bredig, 549, 9: 1; 08. (68) Bredig and von Antropoff, 9, 12: 585; 06. (69) Bredig and Balcom, 25, 41: 740; 08.
- (70) Bredig and Brown, 7, 46: 502; 03. (72) Bredig and Epstein, 93, 42: 341; 04. (73) Bredig and Fajans, 25, 41: 752; 08. (74) Bredig and Fiske, 205, 46: 7; 12. (75) Bredig and Fortner, 25, 37: 798; 04. (76) Bredig and Ikeda, 7, 37: 1; 01. (77) Bredig and Joyner, 9, 24: 285; 18. (78) Bredig and

- Lichty, *9*, 12: 459; 06. (79) Bredig and Müller von Berneck, *7*, 31: 258; 99.
- (80) Bredig and Reinders, *7*, 37: 323; 01. (81) Bredig and Ripley, *25*, 40: 4015; 07. (82) Bredig and Stern, *9*, 10: 582; 04. (83) Bredig and Teletow, *9*, 12: 582; 06. (84) Bredig and Walten, *9*, 9: 114; 03. (85) Bredig and Weinmayr, in *Boltzmann Festschrift*, 839. Leipzig, Barth, 1904. (86) Briner, *42*, 10: 129; 12. (87) Briner and Boubnoff, *42*, 11: 597; 13. (88) Briner and Rossignol, *37*, 6: 647; 23. (89) Brode, *7*, 37: 257; 01. 49: 208; 04.
- (90) Brönsted, *7*, 102: 169; 22. (91) Brönsted, *70*, 42: 718; 23. (92) Brönsted, *Om Syre og Baskatalyse*. Copenhagen, 1926. (93) Brönsted and Pedersen, *7*, 108: 185; 24. (94) Brown, *Diss.*, Heidelberg, 1903. (95) Brunel and Acree, *11*, 43: 505; 10. (95.5) Bruner, *7*, 41: 513; 02. (95.8) Brunner, *7*, 51: 95; 05. (96) Brunner, *7*, 56: 321; 06. (97) Bugarszky, *7*, 48: 63; 04. (98) Burdick, *1*, 44: 244; 22. (99) Bürki, *37*, 1: 231; 18.
- (100) Bürki and Schaaf, *37*, 4: 418; 21. (101) Burrows, *4*, 105: 1260; 14. (102) Burrows, *4*, 115: 1230; 19. (103) Burrows, *4*, 119: 1798; 21. (104) Callow, *83*, 11: 55; 16. (105) Campbell, *4*, 121: 847; 22. (106) Carrara, *22*, 2 II: 407; 93. 3 I: 115, 504; 94. (107) Cavalier, *6*, 18: 449; 99. (108) Chandler and Acree, *7*, 91: 607; 16. (109) Chapman and Jones, *4*, 97: 2463; 10. 99: 1811; 11.
- (110) Christiansen, *7*, 103: 99; 23. (111) Christiansen, *7*, 117: 433, 448; 25. 128: 430; 27. (112) Clarens, *Thesis*, Toulouse, 1913. *84*, 157: 216; 13. (113) Clark, *50*, 10: 679; 06. 11: 353; 07. (114) Clarke, *4*, 97: 416; 10. 99: 1927; 11. 101: 1788; 12. (115) Clarke, *4*, 103: 1689; 13. (116) Clarke and Chapman, *4*, 93: 1638; 08. (117) Clibbens and Francis, *4*, 101: 2358; 12. (118) Cofman, *4*, 115: 1040; 19. (119) Cohen, *7*, 23: 442; 97.
- (120) Cohen, *7*, 37: 69; 01. (121) Cohen and de Boer, *7*, 84: 41; 13. (122) Cohen and Kaiser, *7*, 89: 338; 15. (123) Collins and Wood, *4*, 121: 441; 22. (124) Conant and Kirner, *1*, 46: 232; 24. (125) Conant and Wallingford, *1*, 46: 192; 24. (126) Cox, *4*, 117: 493; 20. (127) Cox, *4*, 119: 142; 21. (128) Creighton, *Diss.*, Zürich, 1911. (128.5) Creighton, *7*, 81: 543; 13. (129) Croker, *4*, 91: 593; 07.
- (130) Csányi, *57*, 40: 81; 19. (131) Cumming, *5*, 78: 103; 06. (132) Daniels and Johnston, *1*, 43: 53; 21. (133) Daniels and Johnston, *1*, 43: 72; 21. (134) Daniels, Wulf and Karrer, *1*, 44: 2402; 22. (135) Dasannacharya, *1*, 46: 1627; 24. (136) Dasannacharya and Sudborough, *318*, 4: 181; 21. (137) Davis, *4*, 95: 1397; 09. (138) Dawson, *4*, 95: 1860; 09. 103: 2135; 13. (139) Dawson and Ark, *4*, 99: 1740; 11.
- (140) Dawson, Burton and Ark, *4*, 105: 1275; 14. (141) Dawson and Powis, *4*, 101: 1503; 12. (142) Dawson and Wheatley, *4*, 97: 2048; 10. (143) Dean, *12*, 35: 605; 13. (144) Dean, *12*, 37: 331; 14. (145) Delépine, *6*, 23: 378, 482; 01. (146) De Lury, *50*, 7: 239; 03. (147) Demierre and Duboux, *42*, 5: 340; 07. (148) van Dijken, *70*, 14: 106; 95. (149) Dimroth, *13*, 335: 1; 04. 338: 143; 05. 364: 183; 09. 373: 336; 10. 377: 127; 10. 378: 382; 10. 399: 91; 13. *9*, 11: 137; 05. (149.5) Dolch, *Diss.*, Leipzig, 1912.
- (150) Drushel, *12*, 33: 27; 12. 34: 67; 12. (151) Drushel, *12*, 37: 514; 14. (152) Drushel, *12*, 39: 113; 15. (153) Drushel, *12*, 40: 643; 15. (154) Drushel and Baneroft, *12*, 44: 371; 17. (155) Drushel and Dean, *12*, 34: 293; 12. (156) Drushel and Dean, *12*, 35: 486; 13. (157) Drushel and Hill, *12*, 30: 72; 10. (157.5) Dumesnil, *34*, 172: 1043; 21. (158) Dunstan and Mussell, *4*, 99: 565; 11. (159) Dushman, *50*, 8: 453; 04.
- (160) Dushman, *1*, 43: 397; 21. (161) Edgar and Wakefield, *1*, 45: 2242; 23. (162) Eggert, *9*, 23: 8; 17. 30: 501; 24. (163) Eggert and Scharnow, *9*, 27: 455; 21. (164) Enklaar, *70*, 23: 419; 04. 24: 419; 05. 25: 297; 06. 29: 173; 10. (165) Eucken, *7*, 71: 550; 10. (166) Euler, *13*, 325: 292; 02. (167) Euler, *25*, 39: 2726; 06. (168) Euler and Cassel, *7*, 84: 371; 13. (169) Euler and Euler, *25*, 38: 2551; 05. 39: 36, 39; 06.
- (170) Euler and Hedelius, *205*, 107: 150; 20. (171) Euler and Lövgren, *93*, 147: 123; 25. (172) Euler, Myrbäck and Rudberg, *19*, 8: No. 28; 23. (173) Euler and Rudberg, *93*, 127: 244; 23. (174) Faber and Reid, *1*, 39: 1930; 17. (175) Fajans, *7*, 73: 25; 10. (176) Fawsitt, *7*, 41: 601; 02. (177) Findlay and Hickmans, *4*, 95: 1004; 09. (178) Findlay and Turner, *4*, 87: 747; 05. (179) Foerster, *52*, 63: 141; 01.
- (180) Foerster, *9*, 23: 137; 17. (181) Foerster and Jorre, *52*, 59: 53; 99. (182) Forster, *50*, 7: 640; 03. (183) Fraenkel, *7*, 60: 202; 07. (184) Francis, *54*, 37: 252; 18. (185) Francis and Geake, *4*, 103: 1722; 13. (186) Francis, Geake and Roche, *4*, 107: 1651; 15. (187) Freas and Reid, *1*, 40: 569; 18. (188) Freundlich and Bartels, *7*, 101: 177; 22. (189) Freundlich and Krestovnikoff, *7*, 76: 79; 11.
- (190) Freundlich and Neumann, *7*, 87: 69; 14. (191) Freundlich and Pape, *7*, 86: 458; 14. (192) Freundlich and Richards, *7*, 79: 681; 12. (193) Freundlich and Seal, *55*, 11: 257; 12. (194) Gadamer, *293*, 239: 294; 01. (195) Garrett and Lewis, *1*, 45: 1091; 23. (196) Geitel, *52*, 55: 417, 429; 97. 57: 113; 98. (197) Gerlinger, *25*, 37: 3958; 04. (198) Giordani, *36*, 54: 844; 24. (199) Golblum and Lew, *42*, 10: 310; 12.
- (200) Goldschmidt, *25*, 28: 3218; 95. (201) Goldschmidt, *9*, 12: 432; 06. (202) Goldschmidt, *7*, 56: 1; 06. (203) Goldschmidt, *7*, 60: 728; 07. (204) Goldschmidt and Bakscht, *13*, 351: 108; 07. (205) Goldschmidt and Branaas, *7*, 96: 180; 20. (206) Goldschmidt and Bräuer, *25*, 39: 97; 06. (207) Goldschmidt and Bräuer, *25*, 39: 109; 06. (208) Goldschmidt and Bürkle, *25*, 32: 355; 99. (209) Goldschmidt and Buss, *25*, 30: 2075; 97.
- (210) Goldschmidt and Ingebrechtsen, *7*, 48: 435; 04. (211) Goldschmidt and Keller, *25*, 35: 3534; 02. (212) Goldschmidt and Kepeller, *25*, 33: 893; 00. (213) Goldschmidt and Larsen, *7*, 48: 424; 04. (214) Goldschmidt and Merz, *25*, 30: 670; 97. (215) Goldschmidt and Oslan, *25*, 32: 3390; 99. 33: 1140; 00. (216) Goldschmidt and Reinders, *25*, 29: 1369; 96. (217) Goldschmidt and Salcher, *7*, 29: 89; 99. (218) Goldschmidt and Scholz, *25*, 40: 624; 07. (219) Goldschmidt, Storm and Hassel, *7*, 100: 197; 22.
- (220) Goldschmidt and Sunde, *25*, 39: 711; 06. (221) Goldschmidt and Wachs, *7*, 24: 353; 97. (222) Griffith and Lewis, *4*, 109: 67; 16. (223) Grube and Krüger, *7*, 86: 65; 14. (224) Grube and Nitsche, *92*, 27: 368; 14. (225) Gruse and Acree, *1*, 39: 376; 17. (226) Guldberg and Waage, *52*, 19: 69; 79. (227) Gyr, *25*, 41: 4308; 08. (228) Gyr, *25*, 41: 4322; 08. (229) von Halban, *Diss.*, Würzburg, 1909. *7*, 67: 129; 09.
- (230) von Halban, *7*, 72: 719; 11. 82: 510; 13. (231) von Halban and Gast, *7*, 91: 593; 16. (232) von Halban and Hecht, *9*, 24: 65; 18. (233) von Halban and Kirsch, *7*, 82: 325; 13. (234) Hantzsch, *25*, 32: 3066; 99. (235) Hantzsch, *25*, 33: 2517; 00. (236) Hantzsch and Kalb, *25*, 32: 3109; 99. (237) Hantzsch and Osswald, *25*, 33: 278; 00. (238) Hantzsch and Schümann, *25*, 32: 1691; 99. (239) Hantzsch and Smythe, *25*, 33: 505; 00.
- (240) Harned, *1*, 38: 1986; 16. (241) Harned, *1*, 40: 1461; 18. (242) Harned and Panstiel, *1*, 44: 2193; 22. (243) Harned and Seltz, *1*, 44: 1475; 22. (244) Hawkins, *4*, 121: 1170; 22. (244.5) Haywood, *4*, 121: 1904; 22. (245) Hemptinne, *7*, 13: 561; 94. (246) Henry, *7*, 10: 96; 92. (247) Hermans, *7*, 113: 337; 24. (248) Herz and Mylius, *25*, 39: 3816; 06. (249) Herz and Rathmann, *25*, 46: 2588; 13.
- (250) Herzfeld, *96*, 8: 132; 21. (251) Heterington and Braham, *1*, 45: 824; 23. (252) Higgins, *4*, 103: 1816; 13. (253) Higson, *4*, 119: 2048; 21. (254) Hinshelwood, *4*, 117: 156; 20. (254.5) Hinshelwood, *5*, 113: 221; 26. 114: 84; 27. (255) Hinshelwood and Burk, *5*, 106: 284; 24. (256) Hinshelwood and Hartley, *4*, 123: 1333; 23. (257) Hinshelwood and Prichard, *4*, 123: 2725; 23. (258) Hinshelwood and Topley, *4*, 125: 393; 24. (259) van't Hoff, *25*, 10: 669; 77.
- (260) van't Hoff, *B99*, I: 217. (261) Holleman, Hartogs and van der Linden, *25*, 44: 704; 11. (262) Holmberg, *7*, 62: 726; 08. (263) Holmberg, *25*, 45: 2997; 12. (264) Holmberg, *7*, 79: 147; 12. (265) Holmberg, *7*, 80: 573; 12. (266) Holmberg, *7*, 84: 451; 13. (267) Holmberg, *52*, 87: 456; 13. 88: 553; 13. (268) Holmberg, *519*, 30: 190, 215; 18. (269) Holmberg, *147*, 5: No. 11; 19.
- (270) Holmberg, *7*, 97: 134; 21. (271) Holmberg and Hahnel, *485*, 1921: No. 10. (272) Hudson, *7*, 44: 487; 03. (273) Hudson, *1*, 29: 1571; 07. 32: 889; 10. (274) Hudson and Brown, *1*, 30: 960; 08. (275) Hudson and Yanovsky, *1*, 39: 1013; 17. (276) Hunter, *7*, 53: 441; 05. (277) Jaeger, *70*, 38: 171; 19. (278) Jellinek, *93*, 49: 229; 06. (278.5) Jellinek and Jellinek, *7*, 93: 325; 19. (279) Johansson, *7*, 79: 621; 12. 81: 573; 13.
- (280) Johansson, *25*, 48: 1262; 15. (281) Johansson, *215*, 12 II: No. 8; 16. (282) Johansson and Sebelius, *25*, 51: 480; 18. (283) Johansson and Sebelius, *25*, 52: 745; 19. (284) Jones and Lewis, *4*, 117: 1120; 20. (285) Joyner, *Diss.*, Karlsruhe, 1913. (286) Judson and Walker, *4*, 73: 410; 98. (287) Kailan, *75*, 115 IIb: 341; 06. 116 IIb: 869, 1093; 07. 117 IIb: 513; 08. (288) Kailan, *57*, 28: 559; 07. (289) Kailan, *13*, 351: 186; 07.
- (290) Kailan, *7*, 85: 706; 13. 87: 619; 14. 89: 641; 15. (291) Kailan, *7*, 94: 111; 20. 101: 63; 22. (292) Kailan, *70*, 41: 592; 22. (293) Kailan and Oboge, *70*, 43: 512; 24. (294) Karlsson, *93*, 145: 1; 25. (295) Kilpi, *7*, 80: 165; 12. (296) Kilpi, *7*, 86: 427; 14. (297) Kilpi, *7*, 86: 641; 14. (298) Kimball and Reid, *1*, 38: 2757; 16. (299) Kiss, *70*, 42: 112; 23. 43: 68, 221; 24.
- (300) Kistiakowsky, *7*, 27: 250; 98. (301) Klemene, *57*, 35: 85; 14. (301.5) Klemene, *57*, 38: 553; 17. (302) Klemene, *13*, 433: 351; 23. (302.5) Klemene and Pollak, *7*, 101: 150; 22. (303) Knibbs and Palfreeman, *83*, 16: 402; 21. (304) Knoblauch, *7*, 22: 268; 97. (305) Knorr, *25*, 44: 2767; 11. (306) Knorr, Rothe and Averbek, *25*, 44: 1138; 11. (307) Knorr and Schubert, *25*, 44: 2772; 11. (308) Koelichen, *7*, 33: 129; 00. (309) Kooij, *7*, 12: 155; 93.
- (310) Krapivín, *42*, 10: 289; 12. (311) Krapivín, *7*, 82: 439; 13. (312) Kremann, *57*, 26: 279; 05. (313) Kremann, *57*, 27: 607; 06. (314) Kremann, *57*, 27: 1265; 06. (315) Kremann, *196*, 19: 289; 13. (316) Kremann, Auer, Oswald and Zoff, *57*, 43: 345; 22. (317) Kremann and Rösler, *57*, 43: 359; 22. (317.5) Kremann, Rösler and Penkner, *57*, 43: 145; 22. (318) Kremann and Wenzing, *57*, 38: 445; 17. (318.5) Kremann, Zoff and Oswald, *57*, 43: 139; 22. (319) Kretzschmar, *9*, 10: 789; 04.
- (320) Krutý and van Duin, *70*, 40: 249; 21. (321) Küster, *7*, 18: 161; 95. (322) Küster and Thiel, *Lehrbuch der allg. physik. und theor. Chemie*, I: 526. Heidelberg, Winter, 1913. (323) Kuhn, *7*, 114: 44; 25. (324) Kuhn and Jacob, *7*, 113: 389; 24. (325) van Laar, *7*, 12: 742; 93. (326) Laebs, *7*, 73: 291; 10. (327) Lamb and Fairhall, *1*, 45: 378; 23. (328) Lamb and Fonda, *1*, 43: 1154; 21. (329) Lamb and Marden, *1*, 33: 1873; 11.
- (330) Lamble and Lewis, *4*, 105: 2330; 14. (330.5) Landolt, *25*, 19: 1317; 86. 20: 745; 87. (331) Lapworth, *4*, 85: 30; 04. (332) Lapworth, *182*, 24: 100; 08. (333) Landolt, *25*, 19: 1317; 86. 20: 745; 87. (334) Levy, *7*, 17: 301; 95. (335) Lewis, *65*, 43: 257; 07. (336) Lewis, *4*, 113: 471; 18. (337) Lewkowitsch, *54*, 17: 1107; 98. (338) Lichty, *50*, 11: 225; 07. (339) Lievin, *34*, 174: 868; 22.

- (340) Lindner, *57*, **28**: 1041; 07. (340.5) Linhart, *12*, **35**: 283; 13. (341) Livingston, *1*, **48**: 53; 26. (342) Livingston and Bray, *1*, **45**: 2048; 23. (343) Ljunggren, *25*, **56**: 2469; 23. (344) Ljunggren, *205*, **145**: 422; 24. (345) Löwenherz, *7*, **15**: 389; 94. (346) Lueck, *1*, **44**: 757; 22. (347) Lundén, *196*, **14**: 1; 09. (348) Luther and MacDougall, *7*, **62**: 199; 08. (349) Luther and Weigert, *7*, **51**: 297; 05.
- (350) McBain and Bolam, *4*, **113**: 825; 18. (351) McMaster and Shriner, *1*, **45**: 751; 23. (352) Madsen, *7*, **36**: 290; 01. (353) Manning, *4*, **119**: 2079; 21. (354) Marshall, Harrison and Acree, *11*, **49**: 369; 13. (355) Martinsen, *7*, **62**: 713; 08. (356) Menshutkin, *13*, **195**: 334; 79. **197**: 193; 79. (357) Menshutkin, *6*, **20**: 289; 80. **23**: 14; 81. **30**: 81; 83. (358) Merrill and Adams, *1*, **39**: 1588; 17. (359) Meyer, *57*, **27**: 1083; 06.
- (360) Meyer, *9*, **13**: 186; 07. (361) Meyer, *9*, **13**: 494; 07. (362) Meyer, *7*, **62**: 59; 08. **72**: 117; 10. (363) Meyer, *7*, **66**: 81; 09. (364) Meyer, *7*, **67**: 257; 09. (365) Meyer, *9*, **15**: 506; 09. (366) Meyer, *25*, **44**: 2725; 11. (367) Meyer, *25*, **44**: 2729; 11. (368) Meyer, *13*, **380**: 212; 11. (369) Meyer, *93*, **115**: 203; 21.
- (370) Meyer and Hopff, *25*, **54**: 579; 21. (371) Meyer and Schoeller, *25*, **53**: 1410; 20. (372) Moran and Lewis, *4*, **121**: 1613; 22. (373) Morrell and Burgen, *4*, **105**: 576; 14. (374) Müller, *25*, **43**: 2609; 10. (374.5) Müller and Müller, *in B13*. (375) Mumm, *7*, **62**: 589; 08. (376) Myers and Acree, *11*, **50**: 396; 13. (377) Nelson and Beegle, *1*, **41**: 559; 19. (378) Nernst, *7*, **47**: 52; 56; 04. (379) Nernst, *93*, **45**: 126; 05. **49**: 213; 06.
- (380) Nernst, *9*, **24**: 335; 18. (382) Nernst and Honmann, *7*, **11**: 352; 93. (383) Nernst and Merriam, *7*, **53**: 235; 05. (384) Nirdlinger, Rogers and Acree, *11*, **49**: 116; 13. (385) Noyes, *7*, **18**: 118; 95. **19**: 599; 96. (386) Noyes, *et al.*, *152*, No. **63**; 07. (387) Noyes and Goebel, *1*, **44**: 2286; 22. (388) Olivier, *70*, **41**: 301; 22. (389) Olivier and Berger, *70*, **41**: 637; 22.
- (390) Olsson, *7*, **118**: 107; 25. (391) Olsson, *Die Abhängigkeit der Hydrolysegeschwindigkeit der Ester von der Konstitution*. Lund, 1927. (392) Orton and Jones, *4*, **101**: 1708; 12. (393) Orton, Watson and Bayliss, *4*, **123**: 3081; 23. (394) Osaka, *7*, **35**: 661; 00. (395) Ostwald, *52*, **27**: 1; 83. (396) Ostwald, *52*, **31**: 307; 85. (397) Palme, *93*, **112**: 97; 20. (397.2) Palomaa, *175*, **4A**: No. 2; 14. (397.5) Palomaa, *175*, **5A**: No. 4; 14. (397.8) Palomaa, *175*, **10A**: No. 16; 17. (398) Patterson and McMillan, *25*, **40**: 2564; 07. **4**, **91**: 504; 07. **93**: 104; 08. (399) Patterson and Montgomerie, *4*, **101**: 26; 12.
- (400) Pennycook, *4*, **125**: 2049; 24. (401) Pennycook, *1*, **48**: 6; 26. (402, 403) von Peskoff and Meyer, *7*, **82**: 129; 13. (404) Pieroni, *36*, **42 I**: 534; 12. (405) Pinnow, *9*, **24**: 21; 270; 18. (406) Poma, *36*, **41 I**: 353; 11. (407) Pomeranz, *57*, **21**: 389; 00. (408) Praetorius, *57*, **26**: 1; 05. **27**: 465; 06. (408.5) Praetorius, *57*, **28**: 767; 07. (409) Price, *7*, **27**: 474; 98.
- (410) Price, *4*, **115**: 1354; 19. (411) Pusch, *9*, **24**: 336; 18. (411.5) Ramsperger, *1*, **49**: 912, 1495; 27. **50**: 714; 28. (412) Reicher, *514*, **12**: 78; 85. **70**, **4**: 347; 85. (413) Reicher, *13*, **228**: 257; 85. **232**: 103; 86. (414) Reid, *11*, **24**: 397; 00. **45**: 327; 11. (415) Reynolds and Werner, *4*, **83**: 1; 03. (416) Rheinlander, *4*, **123**: 3099; 23. (417) Rice, Fryling and Wesolowski, *1*, **46**: 2405; 24. (418) Rice and Kilpatrick, *1*, **45**: 1401; 23. (419) Rice and Lemkin, *1*, **45**: 1896; 23. (419.5) Rice and Ramsperger, *1*, **49**: 1617; 27. **50**: 617; 28.
- (420) Rideal and Thomas, *4*, **121**: 196; 22. (421) Riesenfeld, *93*, **74**: 48; 12. (422) Riiber, *25*, **55**: 3132; 22. (423) Ringer and Skrabal, *57*, **43**: 507; 22. (424) Rivett, *7*, **82**: 201; 13. **85**: 113; 13. (425) Rivett and Sidgwick, *4*, **97**: 732, 1677; 10. (426) Robertson and Acree, *1*, **37**: 1902; 15. (427) Robertson and Acree, *50*, **19**: 381; 15. (427.5) Roebuck, *50*, **6**: 365; 02. **9**: 727; 05. (428) Rosanoff, *1*, **35**: 173; 13. (429) Rosanoff and Potter, *1*, **35**: 248; 13.
- (430) Sachs and Reid, *1*, **38**: 2746; 16. (431) Sagrebin, *7*, **34**: 149; 00. (432) Sand and Kaestle, *93*, **52**: 101; 07. (433) Scatchard, *1*, **43**: 2387; 21. **45**: 1580; 23. (434) Schierz, *1*, **45**: 447, 455; 23. (435) Schoorl, *70*, **22**: 31; 03. (436) Schreiner, *93*, **116**: 102; 21. (437) Schumann, *25*, **33**: 527; 00. (438) Schwicker, *7*, **16**: 303; 95. (439) Segaller, *4*, **103**: 1154, 1421; 13. **105**: 106, 112; 14.
- (440) Selle, *7*, **104**: 1; 23. (440.5) Senter, *7*, **70**: 511; 10. (440.8) Senter, *25*, **45**: 2318; 12. (441) Shields, *7*, **12**: 167; 93. (442) Shroder and Acree, *4*, **105**: 2582; 14. (443) Sidgwick and Moore, *4*, **95**: 889, 899; 09. (444) Skrabal, *57*, **32**: 167; 11. (445) Skrabal, *57*, **32**: 185; 11. (446) Skrabal, *57*, **33**: 99; 12. (447) Skrabal, *57*, **35**: 1157; 14. (448) Skrabal, *9*, **21**: 461; 15. (449) Skrabal, *57*, **37**: 495; 16.
- (450) Skrabal, *57*, **38**: 29; 17. (451) Skrabal, *57*, **38**: 159; 17. (452) Skrabal, *57*, **38**: 305; 17. (453) Skrabal, *57*, **39**: 741; 18. (454) Skrabal, *57*, **43**: 493; 22. (455) Skrabal, *9*, **28**: 224; 22. (456) Skrabal, *9*, **33**: 322; 27.
- (457) Skrabal and Airoidi, *57*, **45**: 13; 24. (458) Skrabal and Baltadschiowa, *57*, **45**: 19; 95; 24. (459) Skrabal and Belavici, *7*, **103**: 451; 23.
- (460) Skrabal and Bilger, *7*, **130**: 29; 27. (461) Skrabal, Brunner and Airoidi, *7*, **111**: 109; 24. (462) Skrabal and Eger, *7*, **122**: 349; 26. (463) Skrabal and Gitschthaler, *7*, **128**: 459; 27. (464) Skrabal and Gruber, *57*, **37**: 535; 16. (465) Skrabal and Hermann, *57*, **43**: 633; 22. (466) Skrabal and Hohlbaum, *57*, **37**: 191; 16. (467) Skrabal and Hugetz, *57*, **47**: 17; 26. (468) Skrabal and Matievic, *57*, **39**: 765; 18. (469) Skrabal and Matievic, *57*, **45**: 39; 24.
- (470) Skrabal and Mirtl, *7*, **111**: 98; 24. (471) Skrabal and Mrazek, *57*, **39**: 495; 18. (472) Skrabal and Mrazek, *57*, **39**: 697; 18. (473) Skrabal and Muhry, *57*, **42**: 47; 21. (474) Skrabal, Pfaff, and Airoidi, *57*, **45**: 141; 24. (474.5) Skrabal and Raith, *57*, **42**: 245; 22. (475) Skrabal and Rieder, *9*, **30**: 109; 24. (476) Skrabal and Ringer, *57*, **42**: 9; 21. (477) Skrabal and Sawiuk, *7*, **122**: 357; 26. (478) Skrabal and Schiffner, *7*, **99**: 290; 21. (479) Skrabal and Singer, *57*, **40**: 363; 19.
- (480) Skrabal and Singer, *57*, **41**: 339; 20. (481) Skrabal and Sperk, *57*, **8**: 192; 17. (482) Skrabal and Weberitsch, *57*, **36**: 211; 15. (483) Skrabal and Weberitsch, *57*, **36**: 237; 15. (484) Skrabal and Zahorka, *57*, **46**: 559; 25. (485) Skrabal and Zahorka, *57*, **48**: 459; 27. (486) Skrabal and Zahorka, *9*, **33**: 42; 27. (487) Skrabal and Zlatewa, *57*, **47**: 39; 26. (487.5) Skrabal and Zlatewa, *7*, **119**: 305; 26. (488) Slator, *7*, **45**: 513; 03. (489) Sluiter, *70*, **24**: 365; 05.
- (490) Sluiter, *70*, **24**: 372; 05. (491) Smith, *7*, **102**: 54; 22. (491.5) Smith, *1*, **47**: 1862; 25. (492) Smith and Paterson, *4*, **1926**: 940. (493) Snethlage, *7*, **90**: 1; 15. (494) Spitalsky, *93*, **53**: 184; 07. (495) Spitalsky, *93*, **54**: 265; 07. (496) Spitalsky, *93*, **56**: 72; 07. **69**: 179; 11. (497) Spohr, *52*, **33**: 265; 86. (498) Spohr, *7*, **2**: 194; 88. (499) Stieglitz and Curme, *25*, **46**: 911; 13.
- (500) Stern, *7*, **50**: 513; 05. (501) Stock and Bodenstein, *25*, **40**: 570; 07. (502) Stock, Gomolka and Heynemann, *25*, **40**: 532; 07. (503) Sudborough and Gittins, *4*, **93**: 210; 08. **95**: 315; 09. (504) Sudborough and Thomas, *4*, **91**: 1033; 07. (504.5) Sudborough and Turner, *4*, **101**: 237; 12. (505) Tassilly, *34*, **157**: 1148; 13. **158**: 335, 489; 14. (506) Tassilly, *27*, **27**: 19; 20. (507) Taylor, *1*, **37**: 551; 07. (508) Taylor, *147*, **2**: No. 34; 13. (509) Taylor and Close, *1*, **39**: 422; 17.
- (510) Thiel, *548*, **1912**: 11. (511) Thiel and Meyer, *93*, **137**: 125; 24. (512) Thiele and Lachman, *13*, **228**: 267; 95. (513) Thomas, *64V*, **27**: 674; 19. **4**, **119**: 1140; 21. (514) Titoff, *7*, **45**: 641; 03. (514.5) Trautz, *9*, **14**: 534; 08. (515) Trautz, *7*, **68**: 295; 10. (516) Trautz, *Lehrbuch der Chemie*, **III**: 132. Berlin, de Gruyter and Co., 1924. (517) Trautz and Bhandarkar, *93*, **106**: 95; 19. (518) Trautz and Dalal, *93*, **102**: 149; 18. (518.5) Trautz and Dalal, *93*, **110**: 1; 20. (519) Trautz and Winkler, *52*, **104**: 53; 22.
- (520) Treub, *42*, **16**: 107; 18. **70**, **42**: 556; 23. (521) Trey, *7*, **18**: 193; 95. **22**: 424; 97. **46**: 620; 03. (522) Tubandt, *13*, **339**: 41; 05. **354**: 259; 07. (523) Tubandt, Mohs, Tubandt and Weinhausen, *13*, **337**: 284; 10. (524) Urech, *25*, **16**: 2270; 83. **17**: 1547; 84. (525) Verkade, *70*, **35**: 79, 299; 15. **36**: 194; 16. **37**: 315; 18. **40**: 192, 199; 21. (526) Visser, *7*, **52**: 257; 05. (527) Voerman, *70*, **23**: 265; 04. (528) Waddell, *50*, **2**: 525; 98. (529) Walden and Centnerszwer, *9*, **15**: 310; 09.
- (530) Walker, *7*, **4**: 319; 89. (531) Walker, *5*, **78**: 157; 07. (532) Walker and Aston, *4*, **67**: 576; 95. (533) Walker and Wood, *4*, **83**: 484; 03. (534) Walton, *7*, **47**: 185; 04. (535) Walton and Withrow, *1*, **45**: 2689; 23. (536) Warburg, *8*, **9**: 1286; 02. **13**: 1080; 04. (536.5) Wasastjerna, *138*, **1**: Nos. 37, 40; 23. (537) Washburn, *1*, **31**: 322; 09. (538) Washburn and Millard, *1*, **37**: 694; 15. (539) Washburn and Strachan, *1*, **35**: 681; 13.
- (540) Washburn and Williams, *1*, **35**: 750; 13. (541) Wegscheider, *7*, **30**: 593; 99. (542) Wegscheider, *7*, **41**: 52; 02. (542.5) Wegscheider, *25*, **39**: 1054; 06. (543) Wegscheider, *57*, **29**: 83, 233; 08. (544) Wegscheider, *57*, **36**: 471; 15. (545) Wegscheider, *57*, **39**: 201; 18. (546) Wegscheider and Amann, *57*, **36**: 549; 15. (547) Wegscheider and Ripper, *57*, **39**: 325; 18. (548) Werner, *4*, **85**: 1376; 04. (549) Werner, *25*, **45**: 3061; 12. (549.5) White and Tolman, *1*, **47**: 1240; 25.
- (550) Wibaut, *70*, **34**: 241; 15. (551) Widmark, *Acta medica Scand.*, **53**: 393; 20. (552) Widmark and Jeppsson, *Skand. arch. physiol.*, **42**: 43; 22. (553) Williams and Sudborough, *4*, **101**: 412; 12. (554) Wilsdon and Sidgwick, *4*, **103**: 1959; 13. **107**: 679; 15. (555) Winkelblech, *7*, **36**: 546; 01. (556) Wood, *4*, **83**: 568; 03. (557) Wood, *4*, **89**: 1831; 06. (558) Wood, *4*, **89**: 1839; 06. (559) Wourtsel, *34*, **170**: 229; 20.
- (560) Wulf, Daniels and Karrer, *1*, **44**: 2398; 22. (561) Wunderly, *7*, **112**: 175; 24. (562) Yamasaki, *1*, **42**: 1455; 20. (563) Young, *1*, **23**: 119; 00. **24**: 297; 01. (564) Abel and Schmid, *7*, **136**: 430; 28. (565) Baur, *7*, **140**: 194; 29.

THE KINETICS OF BIOCHEMICAL REACTIONS

J. TEMMINCK GROLL

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INTRODUCTION

The following standard works and monographs, used in composing these tables, should be consulted in the first instance for further information on this subject. The periodical literature is so extensive that only a very small part of it could be cited here.

Arrhenius, *Immunochemie. Anwendungen der physikalischen Chemie auf die Lehre von den physiologischen Antikörpern*. Leipzig, Akadem. Verlagsges., 1907.

Bayliss, *The nature of enzyme action*. London, Longmans, 1919.

Effront, *Les catalyseurs biochimiques dans la vie et dans l'industrie (fermentes protéolytiques)*. Paris, Dunod et Pinat, 1914.

Euler, *Chemie der Enzyme*. München, Bergmann, 1920-22.

Euler and Lindner, *Chemie der Hefe und der alkoholischen Gärung*. Leipzig, Akadem. Verlagsges., 1915.

Falk, *The chemistry of enzyme action*. New York, Chem. Cat. Co., 1924.

Harden, *Alcoholic fermentation*. London, Longmans, 1923.

Michaelis, *Die Wasserstoffionenkonzentration*. Berlin, Springer, 1922.

Oppenheimer, *Die Fermente und ihre Wirkungen*. Leipzig, Vogel, 1913. 5th ed., Leipzig, Thieme, 1924-26.

Zunz, *Fermente*. In Abderhalden, *Biochemisches Handlexikon*, V: 538-665; 11.

SYMBOLS

For explanation of equations and symbols, v. p. 115.

HYDROLYSIS OF FATS

LIPASE, RICINUS

Time.—According to Nieloux (127) and Taylor (162) the reaction is monomolecular. According to Connstein (35), $x/\sqrt{t} = k$. In a mixture of 4 g of 0.1% H_2SO_4 + 5 g ric. seed + 6.5 g ric. oil he finds:

t (min)	15	30	45	60	90	150	210	330	1620
x	12	20	30	33	41	54	59	68	81
x/\sqrt{t}	3.11	3.65	4.47	4.26	4.32	4.51	4.07	3.74	2.01

Using 0.02 g ric. lip. + 1 g triolein + 1 cm³ 0.01N acetic acid, shaken at 20°C, Jalander (96) finds $\left(k_1 = \frac{10^4}{t} \log_{10} \frac{a}{a-x}\right)$:

t (min)	10	20	30	60	120	240
cm ³ 0.1N NaOH	6.76	11.55	15.93	18.85	26.18	28.54
% split	20.39	34.87	48.05	56.86	78.97	86.54
k ₁	100	93	93.9	60.6	56.2	35.7
x/\sqrt{t}	6.4	7.8	8.7	7.3	7.2	5.7

Enzyme Concentration (= E).—Jalander (96) finds:

10 ³ E	cm ³ 0.1 N NaOH	% split	%/E	10 ³ E	cm ³ 0.1 N NaOH	% split	%/E
1	1.68	4.46	4.46	10	15.63	41.57	4.16
2	3.40	9.04	4.52	15	19.96	53.08	3.54
3	5.20	13.85	4.65	20	22.18	58.99	2.99
4	6.70	17.82	4.45	25	23.05	61.30	2.41
5	8.31	22.10	4.40				

Temperature.—Reaction checked at 50°C (35).

pH.—Optimum at ± 5 (76), checked at 3.

Activation.—0.2% $MnSO_4$ activates strongly (16, 35). Bile salts (38) and saponin decrease action. For neutral salts, v. (58).

Reversibility.—v. (96, 162); v. also (59, 68, 91). Jalander (96) finds at 20°C, with 2 min shaking 5 times daily:

Splitting of ester 0.01 g dry ric. lip. + 1.0 g triolein + 1 cm ³ 0.01 N acetic acid			Synthesis of ester 0.01 g dry ric. lip. + 0.957 g oleic acid + 0.104 g glycerol + 1 cm ³ 0.01 N acetic acid		
Days	cm ³ 0.1 N alkali	% oil split	Days	cm ³ 0.1 N alkali	% oleic acid bound
15	29.51	89.02	15	30.31	11.16
30	29.30	88.37	30	30.35	11.04

LIPASE, PANCREATIC

Time.—Using 10 cm³ olive oil + 3.9 cm³ 0.1 N alkali + 0.25 cm³ N $CaCl_2$ + 1 cm³ paner. extr. (hog), Kanitz (98) found:

t (min)	70	140	288	405	1455
x/t	0.131	0.088	0.065	0.057	0.023
x/\sqrt{t}	1.1	1.04	1.12	1.15	0.90

Enzyme Concentration (E).—Velocity proportional to E (100).

Temperature (100).

°C	0	10	20	30
k_{30+10}/k_0		1.50	1.34	1.26
A (cal.)		6300	4800	4100

pH.—Optimum at 8.3-9 (145).

Activation.—For neutral salts, v. (61, 98, 123, 132, 164).

LIPASE OF TISSUE EXTRACTS

Spontaneous increase of activity (128). Ester-hydrolyzing action of tissue and tumor extracts after different time-intervals, preserved at room temperature.

<div>Ester \ Days</div>		Whole rats						Rabbit livers	
		3.5 days old			22 days old			28 days pregnant	
								0	15
		0	8	16	0	3	9	0	15
Phenyl acetate.....		4.30	4.03	4.08	6.06	5.94	5.97	4.56	2.88
Glyceryl triacetate.....		2.72	2.94	2.92	3.71	3.35	3.28	3.06	2.78
Methyl butyrate.....		1.31	1.73	1.68	2.62	3.55	3.20	3.63	3.72
Benzyl acetate.....		0.79	0.94	0.88	1.26	1.68	1.67	1.78	1.96
Ethyl acetate.....		0.78	0.83	0.81	1.24	1.39	1.40	1.23	1.48
Methyl acetate.....		0.73	0.74	0.68	1.05	1.16	1.05	1.60	1.80
Ethyl butyrate.....		1.40	1.75	1.62	2.69	3.55	3.37	2.64	3.05
Methyl benzoate.....		0.23	0.20	0.21	0.68	0.61	0.61	0.82	0.82
Ethyl benzoate.....		0.36	0.36	0.33	0.77	0.82	0.82	0.54	0.55
Isobutyl acetate.....		0.80	0.94	1.00	1.33	1.70	1.66	1.79	1.88

HYDROLYSIS OF CARBOHYDRATES

Starch-Splitting Enzymes

AMYLASE, MALT

Time.—With this and also with the other amylases, no concordant data are to be found, in consequence of the complicated structure of the starch molecule.

According to Brown (25), k of the monomolecular reaction increases rapidly with time.

According to Henri (83) and Euler (51), the monomolecular k is approximately constant; according to Philoche (134, 135), only after 30% of the starch is split.

Substrate Concentration; v. also (7, 39, 44, 74, 102, 105, 107, 129, 136, 153, 155, 156, 166).

% starch.....	1	1.5	2	2.5	3
g maltose in 1 hr.....	0.24	0.30	0.338	0.397	0.397

AMYLASE, TAKA (ASPERGILLUS ORYZAE)

Time.—At 31.5°, 1% starch and taka-diaxase 1:20 000, Philoche (134) found:

t_1 (min).....	21	51	113	224	390
x/a	0.06	0.11	0.15	0.26	0.36
10^4k	12.3	10.0	6.2	5.8	5.0

pH.—Optimum at 4.8 (152).

Activation.—Neutral salts, no definite activation (147, 152). NaCl activates above 0.1 N (174).

AMYLASE, YEAST

pH.—Optimum at 4.5 to 6 (72).

AMYLASE, SALIVA

Time.—Should be monomolecular according to Taylor (163).

Temperature.— $k_{\theta+10}/k_{\theta}$, (20–30°) = 2. $A = 12\,300$ (168).

Enzyme Concentration.

E	1	2	3	5	Lit.
% maltose in 10 min....	0.077	0.150	0.202	0.385	(55)

pH.—Optimum at 6.0 to 6.4 (40, 72, 75, 115, 142).

Neutral Salts.—(71).

AMYLASE, PANCREATIC

Time.—(83, 101, 133, 134).

pH.—Optimum = 5–7 (Hog); = 6–7.5 (Ox); = 6–8 (Man) (72).

Hydrolysis of Raffinose

RAFFINASE, YEAST

Time.—According to Willstätter (172), $\left(k = \frac{10^5}{t} \log_{10} \frac{a}{a-x}\right)$:

Min	First experiment		Second experiment	
	% split	k	% split	k
10	6.9	310	8.9	404
20	14.5	340	18.5	445
30	21.6	352	24.4	404
45	31.3	362	32.6	381
60	39.4	362	40.5	376
80	48.4	359	49.2	367
110	60.0	362	59.4	356
150			69.5	344
160	72.1	346		
200			77.5	324
220	82.1	340		
260			85.9	327
∞	100.0		100.0	

Enzyme Concentration (172); cf. (11).

E (cm ³ in 25) ...	0.25	0.5	1.0	2.5	5.0
t (min).....	400	200	100	40	20
% split.....	24.8	25.6	25.6	26.2	26.2

pH.—Per cent split at different pH.

pH	1.5	2.5	3.0	4.0	5.0	6.0	6.5	7.0	7.5	8.0
%	47.5	55.8	58.9	63.3	64.1	58.7	50.5	37.0	14.4	9.4

RAFFINASE, ALMONDS

Time.—Using a 2.3% solution, and 1 g emulsion, at 30°, and pH = 4.2, Willstätter (171) found monomolecular k :

t (hr).....	1	2.5	6	9	22.5	26	30.5
% split.....	3.5	8.5	18.0	25.6	55.2	60.5	66.0
10^4k	351	355	330	328	350	356	352

pH.—Optimum at 4.1 (171).

Hydrolysis of Sucrose

INVERTASE, YEAST

Time.— $\left(k = \frac{10^5}{t} \log_{10} \frac{a}{a-x}\right)$ according to Hudson (92):

t (min).....	30	60	90	110	130	150
k	558	530	539	534	559	533

According to Michaelis (117):

t (min)...	0.5	21	60	130	190.2	246.0
x	0.010	0.389	1.074	2.205	3.004	3.590
10^5k		1.45	1.51	1.64	1.71	1.76

According to Nelson and Vosburgh (126):

t (min).....	35	80	159.5	265	425	785
% inversion ..	9.42	21.02	39.66	60.02	80.04	94.88
10^5k	1.23	1.28	1.38	1.50	1.65	1.64

Concentration of Enzyme and Substrate.—Relation between time for 40% inversion (t_{40}) and concentration of sucrose, (C_s) at pH = 5.5 (126):

C_s g/l	cm ³ invertase, y	t_{40}	$\frac{t_{40} \times y}{C_s}$
50	2	47.5	19.0
50	1	93	18.6
100	2	79	15.8
100	1	163	16.3
200	2	175	17.5
200	1	376	18.8

Temperature.—According to Kjeldahl (103) calculated by Herzog; cf. (123.1).

°C.....	0	18	30	40	45
k	17	60	113	179	228
A	11 100	9 300	8 800	9 600	
$k_{\theta+10}/k_{\theta}$	2.01	1.69	1.58	1.62	

According to Tammann (160); v. also Euler and Laurin (48).

°C.....	0	21	30.1	39.8	50
k	18	120	163	216	302
A	14 500	6 000	5 500	6 600	
$k_{\theta+10}/k_{\theta}$	2.47	1.40	1.34	1.39	

pH.—Optimum: 3.5–5.5 at 52° (158) and at 22° (117).

Activation.—Neutral salts (28, 57); salts of heavy metals (52); various organic substances (53); v. also (14, 17, 24, 29, 30, 31, 32, 33, 47, 50, 84, 92, 120, 124, 125, 126, 131).

INVERTASE, BANANA

Time.—No satisfactory data (62).

pH.....	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
Action.....	183	481	489	478	458	375	135	52

For effect of aging, v. (111); v. also (63).

Hydrolysis of Maltose

MALTASE, YEAST

Time.—No concordant results, *v.* (9, 87, 107, 173). According to Willstätter the reaction is monomolecular (173).

<i>t</i> (min)...	10	20	30	40	60	80	100	150	200	300
% split...	19.2	26.9	33.8	37.7	44.0	49.0	53.2	61.2	66.4	75.0

Enzyme Concentration.—(173).

E.....	2	5	10
<i>t</i> (min).....	150	60	30
% split.....	34.2	34.4	34.5

Temperature.—According to Lintner and Kröber (108), calculated by Herzog; *cf.* (130).

°C.....	10	20	30	40
Velocity.....	1	1.9	2.74	3.58
A.....	10 600	6 500	5 100	
$k_{\theta+10}/k_{\theta}$	1.90	1.44	1.28	

pH.—Optimum at 6.1–6.8, with “untergährige Bierhefe,” brewers’ bottom yeast (122).

Activation.—Neutral salts, no effect except Ca which decreases action.

MALTASE, TAKA DIASTASE

pH.—Optimum at *ca.* 4 (97); at 4.1 (8); *v. also* (34).

Hydrolysis of Lactose

LACTASE, ALMOND

Time.—With 0.7% solution, 0.5 g emulsin, pH at 4.4, 30°C, monomolecular *k* (171); *v. also* (9, 10).

<i>t</i> (hr).....	4	7	21	24	30	46
% split.....	15	24	55	61	69.5	85
10 ⁴ <i>k</i>	410	390	380	390	396	410

pH.—(171).

pH.....	3.2	3.8	4.4	4.9	6.0	7.0	8.0
% split.....	30	39	44	41	30	8.5	2.5
10 ³ <i>k</i>	9.7	13.4	15.7	14.3	9.7	2.3	0.7

Hydrolysis of α -Glucosides α -GLUCOSIDASE, YEAST

Time.—2.7% solution of glucoside at 30°C (174).

<i>t</i> (min).....	10	20	40	60	100	160	240	340
% split.....	7.6	12.3	20.4	26.7	35.9	45.9	53.1	60.2

Enzyme Concentration.

E (cm ³ in 50 cm ³).....	1	2	5	10
<i>t</i> (min).....	800	400	160	80
% split.....	32	32	31.4	31.4

$E \times t = \text{ca. constant}$ (174).

pH.—Hydrolysis of maltose and of α -methylglucoside at pH = 6.0 to 7.8. T. V. = time value of yeast extract (174):

pH	Maltose		Glucoside	
	% split	T. V.	% split	T. V.
6.0	43.0	86	32.7	142
6.4	42.8	87	33.3	137
6.8	42.7	87	32.7	142
6.8	42.7	87	28.2	280
7.2	41.4	93	24.5	340
7.8	40.3	99	24.5	340

Reversibility.—Influence of alcohol concentration (C_A) on yield, % bound; 1% solution of glucose; aqueous extract of yeast at 16°C (20):

C_A	days	%	C_A	days	%	C_A	days	%	C_A	days	%
0	0	0	10	8–14	20.6	20	31–35	32.6	30	14–20	14.4
2	1–4	6.9	12	8–14	22.9	22	31–35	31.7	32	1–4	8.2
4	1–4	10.0	14	8–14	26.7	24	28–31	30.0	34	1–4	
6	1–4	14.0	16	14–20	29.7	26	24–28	28.7	36		5.2
8	8–14	19.4	18	20–24	31.2	28	14–20	25.6			

Synthesis of α -Methyl- α -glucoside

Alcohol Concentration (C_A).—1% solution of glucose, extract of dried yeast, 16–18°C (20).

C_A g/100 cm ³ ...	10	12	14	16	18	20	22	24
Days.....	16–20	18–22	18–22	18–22	35–38	35–38	42–48	31–35
% bound.....	45.0		50.2	54.0	59.0	59.6	61.1	54.0

Quantity of Enzyme.—Solution of 1 g glucose and 16 g methyl alcohol in 100 cm³. Yeast powder:

Yeast, g	%	Yeast, g	Days	%	Yeast, g	Days	%
0.025	3.01	0.15	30–40	11.56	0.50	40–43	50.43
0.05	3.59	0.20	60–80	21.86	1.00	22–25	53.15
0.10	6.41	0.25	120–140	34.20	2.00	11–15	53.15

Quantity of Glucose.—18 g methyl alcohol in 100 cm³; aqueous extract of yeast (20).

g Gl./100 cm ³ ...	1	2	5	10	15
<i>t</i> (days).....	22–31	30–40	60–70	150–180	180–210
Gl. bound %....	57.5	57.8	54.7	52.4	44.6

Hydrolysis of β -Glucosides

EMULSIN, ALMOND

Time.—0.8% glucoside (β -methylglucoside); 0.1 g emulsin pH = 4.4, 30°C (171).

Hr.....	2	16	19	23	26	41	48
% split.....	7.1	48.35	57.45	62.0	65.4	81.0	84.2
10 ⁴ <i>k</i>	370	410	450	420	410	400	380

Enzyme Concentration.—(161, 171).

Enzyme.....	1	2	4	Lit.
Initial velocity.....	1	2.3	3.9	(169)

pH.—Optimum at 4.7–5.1 (171).

Temperature.—According to Tammann (161), calculated by R. Herzog.

°C.....	0	20.5	30	40.2	50.3
<i>k</i>	1	5.6	14.0	21.0	30.5
A.....	13 400	17 200	7 600	7 300	
$k_{\theta+10}/k_{\theta}$	2.31	2.62	1.49	1.44	

Reversibility.—Synthesis of β -ethylglucoside. Solution of 1 g glucose in 100 cm³; 0.4 g emulsin (21):

Alco- hol	Reaction duration, days	Glucose not bound	Alco- hol	Reaction duration, days	Glucose not bound	Alco- hol	Reaction duration, days	Glucose not bound
100	No reaction		80	10–15	0.345	30	5–10	0.767
95	55–58	0.140	60	10–15	0.553	20	<5	0.844
90	30–35	0.203	50	10–15	0.648	10	<5	0.894
85	20–25	0.300	40	5–10	0.691			

Synthesis of β -Ethylgalactoside (23)
Alcohol Concentration.— C_A in g/100 cm³:

C_A	% galactose bound after, months			
	1	4	8	9½
20	15.92	19.70	27.77	29.47
30	22.16	29.92	37.31	38.52
40	23.32	33.40	39.06	39.64
50	28.57	38.10	45.84	45.36
60	36.29	47.32	49.24	49.90
70	56.75	57.28	59.41	59.06
80	59.66	67.55	69.20	69.20

v. also (22, 82, 93).

HYDROLYSIS OF PROTEINS

Pepsinases

PEPSIN, GASTRIC

Enzyme Concentration.—1 g globulin and 5 cm³ 5% HCl in 100 cm³ for 16 hr at 37.5°C; x = constant $\times E^{1/2}$, where x is the rotation of the peptone and E the pepsin concentration (148). According to Arrhenius (12) a more accurate relation is $Ek = \frac{a}{t} \log \frac{a}{a-x} - \frac{x}{t}$.

Time.— $E \times t = ca.$ constant, where t is the time. Accuracy $\pm 10\%$. See further (12).

Temperature.—(88).

°C.....	14	19.4	24.2	28.9	35.5
% split.....	0.95	2.14	3.67	4.9	7.7
A.....	25 400	19 600	11 100	12 800	
$k_{\theta+10}/k_{\theta}$	4.5	3.08	1.85	1.98	

v. also (4, 6, 26, 73, 90, 104, 138, 149, 151, 157, 165).

pH.—Optimum at 1.5–2 (158).

Trypsases

TRYPSIN, PANCREATIC

Time.—According to Arrhenius (12), who calculated experiments of V. Henri and des Bancelles (85), $x = kt^{1/2}$ where x is the increase in conductivity.

Soln.....	t (min)	10	20	30	40	55
4% gelatin.....	x (obs.)	27.3	44	53	58.7	65.7
44.3°C, $k = 7.37$	x (calc.)	29.3	41.5	50	58.7	68.8
Casein in 2% NaHCO ₃ soln.....	x (obs.)	24	36	41	42	44
44°C, $k = 7.59$	x (calc.)	24	34	42	48	54

Enzyme Concentration.— t_1, t_2, t_3 = times for same decomposition.

E	t_1	$t_1 \times E$	t_2	$t_2 \times E$	t_3	$t_3 \times E$
0.5	37	18.5	89	44.5	720	360
1	19	19	45	45	480	480
2	10	20	24	48	274	548
2.5	7.5	18.8	19	47.5	245	613
4	4.5	18	13	52	226	904

Temperature.—(130).

°C.....	19.4	25.2	29.8	35.8
% split.....	3.3	7.1	9.5	18.2
A.....	23 000	11 400	20 200	
$k_{\theta+10}/k_{\theta}$	3.75	1.88	2.96	

pH.—Trypsin from pancreatin "Rhenania" acting on "pepton Riddel" (118); cf. (140, 141), "Sørensen-method."

pH.....	3.65	4.25	4.78	5.78	6.49	6.98
Activity.....	0	0.028	0.075	0.31	0.58	0.78
pH.....	7.01	7.02	7.68	9.17	11.26	
Activity.....	0.84	0.86	1.00	0.87	0.085	

v. also (18, 116).

TRYPSIN, MALT

Temperature.—(170).

°C.....	15	25	36	45
v	0.42	1.42	3.80	5.34
A.....	20 900	16 500	7 400	
$k_{\theta+10}/k_{\theta}$	3.38	2.45	1.46	

Peptases

EREPSIN, HOG INTESTINE

Time.—0.10 glycylglycine; 0.04 N NaOH; 5 g erepsin prep. in 100 cm³; 37°C. $k_1 = \frac{10^3}{t} \log_{10} \frac{a}{a-x}$. Conductivity method (43).

t (min).....	0	7	13	20	28	36
$10^3(a-x)$	930	837	763	690	620	550
k_1		6.54	6.60	6.48	6.30	6.33

Temperature.—(2).

°C.....	25	35	45
v	1	2.35	3.5
A.....	14 800	8 600	
$k_{\theta+10}/k_{\theta}$	2.25	1.56	

v. also (1, 3, 5).

EREPSIN, YEAST JUICE

Time and pH.—0.4 g glycyl- l -leucine in 10 cm³ H₂O + 20 cm³ phosphate + 2 cm³ yeast juice. pH electrometr.; 25°C. For the formol titration are taken 5 cm³ $a = 62.5$ mg. $k_0 = 10^4x/t$, $k_1 = \frac{10^4}{t} \log_e \frac{a}{a-x}$, $k_2 = \frac{10^4x}{t^{1/2}}$ (66).

pH	t (min)	x , mg	k_0	k_1	k_2
6.27	10	10.5	10.5	184	
	20	22.4	(11.2)	(222)	
	30	29.9	9.9	217	
	40	38.0	9.5	234	
7.37	10	15.2	25.6	279	25.6
	20	25.8	30.6	266	30.6
	30	35.2	34.1	276	34.1
	40	41.6	34.9	273	34.9
8.41	10	23.5		472	39.5
	20	37.2		401	44.3
	30	44.5		415	43.2
	40	49.3		389	41.2
9.33	10	11.6		205	36.7
	20	18.4		174	41.2
	30	25.4		174	24.6

MILK COAGULATION BY RENNET

Time and Concentration of Rennet.—Time of curdling \times concentration of rennet = constant ($\pm ca.$ 30%), with calf rennet, not with that of swine or man (112).

Temperature.—(66).

°C.....	25	30	35	40
v	1	1.69	3.15	5.40
A.....	18 600	22 300	20 800	
$k_{\theta+10}/k_{\theta}$	2.86	3.32	2.94	

pH.—Optimum at 5 (36). In the presence of Ca salt, optimum at 6–6.4 (119).

Calcium Salts.—For effect, *v.* (146); *v. also* (65, 66, 77, 89, 95, 106, 139, 159).

HYDROLYSIS OF UREA

UREASE, SOY-BEAN

Time.—According to (15), $m \times t = \frac{nc}{0.434} \log_{10} \frac{1}{1-y} + ay$.

x = concentration urea (g in 100 cm³)

c = concentration H-ions (g in 100 cm³)

n = coefficient of absorption (1 g H-ions absorbs n times the radiation absorbed by 1 g urea)

$$y = \frac{a-x}{a}$$

$$m = \text{velocity constant} = \frac{0.0327 \log_{10} \frac{1}{1-y} + 0.01y}{t}$$

t (min).....	20	30	50	70	90	110
cm ³ 0.1 N NH ₃	1.78	2.58	3.68	5.08	5.88	6.51
y	0.223	0.323	0.460	0.635	0.735	0.814
10 ⁶ m	290	292	267	295	291	291

pH.—(15).

pH.....	5.84	6.13	6.40	6.67	7.0	7.21
10 ⁵ m	20.5	22.1	26.7	35.4	51.3	67
pH.....	7.52	7.64	7.80	8.03	8.13	8.65
10 ⁵ m	75.2	70.3	62.3	47.3	41.7	24.4

Concentration of Urea.—cm³ of $\frac{1}{50}$ N NH₃ formed in 120 min in 12 cm³ (15); *v. also* (46, 60, 69, 70, 109, 110, 113, 114, 143, 144, 167).

C_U \ pH	5.83	6.68	6.81	6.89	7.14	7.47	7.83	8.10
0.03	0.068	0.58	0.95	1.2	1.65	3.2	3.2	2.9
0.05		0.9	1.4	1.7	2.25	3.45	3.75	3.2
0.08	0.164	1.3	1.9	2.3	2.7	4.05	3.55	3.2
0.1	0.21	1.6	2.15	2.5	3	4.15	4.1	3.4
0.2	0.375	2.3		3.4	3.55	4.65	4.3	3.7
0.5	0.85	3.3	3.9	4.3	4.1	5	4.5	3.8
1	1.5	3.9	4.5	4.65	4.3	5.05	4.25	3.9
2	2.75	4.45	4.9	5.2	4.5	5.15	4.75	4.1
4	3.2	4.8	5.15	5.4	4.45	5.25	4.6	3.9
6	4.15	4.85	5.2	5.3	4.45	4.85	4.35	3.65
8	4.65	4.8	5	5.15	4.25	4.6	4	3.25

DECOMPOSITION OF PEROXIDES

CATALASE, YEAST

Time.—Values of 434.3k (94).

25°C, $\frac{1}{90}$ mole H₂O₂

t (min).....	0	5	10	15	20	25	30
cm ³ KMnO ₄ ...	41.8	31.5	23.7	17.9	13.5	10.2	7.6
434.4k.....		24.57	24.67	24.55	24.54	24.50	24.69

0°C, $\frac{1}{33}$ mole H₂O₂

t (min).....	0	5	10	20	30	40	60
cm ³ KMnO ₄ ...	48.4	38.1	30.1	18.7	11.6	7.2	2.8
434.4k.....		20.78	20.62	20.65	20.67	20.68	20.62

Enzyme Concentration.— $k = 0.183E^{0.366} \pm \text{ca. } 1\%$.

Living Yeast.—Splitting of H₂O₂ by living yeast, pH = 6.8; 0°C, according to Euler (45).

A = 0.1 g of yeast in 100 cm³ 0.4% Na phosphate; of this are taken 50 cm³ + 50 cm³ 0.02 N H₂O₂

B = 0.2 g of yeast in 100 cm³ 0.4% Na phosphate; of this are taken 50 cm³ + 50 cm³ 0.02 N H₂O₂

C = 0.3 g of yeast in 100 cm³ 0.4% Na phosphate; of this are taken 50 cm³ + 50 cm³ 0.02 N H₂O₂

Living Yeast.—(Continued)

Min	A		B		C	
	cm ³	10 ⁴ k	cm ³	10 ⁴ k	cm ³	10 ⁴ k
0	5.2		5.2		5.2	
15	5.0	11	4.8	23	4.5	42
30	4.8	11	4.4	24	3.7	49
45	4.7	10	4.1	23	3.2	47
60	4.5	10	3.8	21	2.8	45

Activation.—The activating action of toluene, chloroform, phenol and thymol on the H₂O₂-splitting capacity of living yeast (45); *v. also* (135).

A: 0.2 g of yeast in 100 cm³ water, saturated with 0.5 cm³ toluene, chloroform, etc., 50 cm³ of this + 50 cm³ 0.0185 N H₂O₂, pH = 6.2.

B: The same, without toluene, chloroform, etc., pH = 6.8.

Toluene

t (min)	0	10	20	30	40	50	60
A	cm ³	5.2	4.8	4.4	4.0	3.8	3.5
	10 ⁴ k		35	36	38	34	33
B	cm ³	5.2		4.9	4.7	4.6	4.5
	10 ⁴ k			13	13	13	12

Chloroform

t (min)	0	20	30	40	50
A	cm ³	5.6	2.7	1.8	1.4
	10 ⁴ k		158	164	150
B	cm ³	5.6	5.05	4.8	4.6
	10 ⁴ k		22	22	21

Thymol, cm³ of O₂ 15°C, humid

t (min)	15	30	60	90	105
cm ³ {	A	12	14	22	28
	B	11	13	16	20

Phenol = A, 0.0 B, 0.5 g B, 2 g

Min	pH = 7	pH = 6.9	pH = 6.6
20	7.5	9.0	14.2
40	9.5	14.5	18.6
60	11.5	18.3	21.5
80	13.5	19.5	22.5

CATALASE, BLOOD (HEMASE)

Time.—Monomolecular k (150).

t (min).....	0	5	10	20	30	50
H ₂ O ₂ concn.....	46.1	37.1	29.8	19.6	12.3	5.0
434.3 <i>k</i>		19.0	19.2	19.0	19.3	19.4
Enzyme concentration.....	E	3	6	8	24	
	v	28	58	72	230	
	v/E	9.33	9.66	9.00	9.6	

Enzyme Concentration.—(54).

E	v	$v/E^{1/2}$	E	v	v/E
100	100	10.0	20	40.3	2.01
50	76.7	10.8	15	32.7	2.18
40	63.8	10.06	10	22.6	2.26
30	57.4	10.50	6	16.6	2.76
			4	9.5	2.37
			2	3.52	1.76

Temperature.—Herzog.

°C.....	0	10	$k_{\theta+10}/k_{\theta}$
v_I	0.0120	0.180	± 1.5
v_{II}	0.192	0.0294	

OTHER CATALASE

Liver (121, 137).

Milk (56).

Fat tissue (13).

Boletus scaber (42).

Apple-leaf tissue (81).

ALCOHOLIC FERMENTATION

Time.—1 l of a 1.136 N dextrose solution with 1.2 g acetone yeast (dead). 24.5°C. k_1 = monomolecular k ; $k_a = \frac{1}{2l} \log_e \frac{a+x}{a-x}$ (86).

t (min).....	0	120	240	1200
$a - x$	1	0.961	0.922	0.673
$434.3 \times 10^3 k_1$		144	147	143
$434.3 \times 10^3 k_a$		141	141	123

t (min).....	1440	1740	2690	3000
$a - x$	0.612	0.549	0.396	0.354
$434.3 \times 10^3 k_1$	148	149	149	150
$434.3 \times 10^3 k_a$	123	121	120	111

t (min).....	0	200	301	465	561	923
$a - x$	520	493	477	454	443	407
$10^4 k_1$ (41).....		1.16	1.25	1.26	1.24	1.15

Living yeast cells (67)

t (min).....	0	34	68	86	136	156	182	215
°Rotation.....	36.4	34.2	31.9	30.7	27.7	26.7	24.7	23.4
$10^5 k$		154	158	157	156	152	156	151

t (min).....	246	273	304	330	404	452	572	
°Rotation.....	21.6	20.3	18.8	17.2	14.0	12.0	8.4	
$10^5 k$	152	151	151	154	152	155	154	

Substrate Concentration.—20 cm³ yeast juice in presence of toluene at 22°C (27).

Sucrose:		CO ₂ in g after:		
Wt.	%	6 hr	24 hr	96 hr
2.2	10	0.17	0.50	0.55
3.52	15	0.14	0.53	0.64
5	20	0.13	0.54	0.73
6.66	25	0.13	0.52	0.80
8.56	30	0.12	0.46	0.81
10.76	35	0.12	0.40	0.82
13.33	40	0.11	0.36	0.82

Antiseptics (78).

Substance	Effect on total fermentation
Concentrated solution of glycerol...	Slight diminution
Concentrated solution of sugar.....	Slight increase
Toluene (to saturation or excess)...	Less than 10% diminution
Chloroform, 0.5%.....	Slight increase
Chloroform, 0.8% (saturation).....	No change
Chloroform large excess, 17%.....	64% diminution
Chloral hydrate, 0.7%.....	Increase up to 27%
Chloral hydrate, 3.5–5.4%.....	Completely destroyed
Phenol, 0.1%.....	No change
Phenol, 0.5%.....	40% diminution
Phenol, 1.2%.....	Completely destroyed
Thymol, 1%.....	Slight diminution
Thymol, 5%.....	Marked diminution
Benzoic acid, 0.1%.....	7% diminution
Benzoic acid, 0.25%.....	26% diminution
Salicylic acid, 0.1%.....	10% diminution
Salicylic acid, 0.27%.....	35% diminution
Formaldehyde, 0.12%.....	20% diminution
Formaldehyde, 0.24%.....	30–60% diminution
Acetone, 6%.....	20% diminution
Acetone, 14%.....	80% diminution
Alcohol, 6%.....	0–2% diminution
Alcohol, 14%.....	75% diminution
Sodium fluoride, 0.5%.....	99% diminution
Sodium fluoride, 2.0%.....	Almost completely destroyed

Antiseptics.—(Continued)

Substance	Effect on total fermentation
Ammonium fluoride, 0.55%.....	Completely destroyed
Sodium azoimide, NaN ₃ , 0.36%...	Slight diminution
Sodium azoimide, NaN ₃ , 0.71%...	Marked diminution
Quinine hydrochloride, 1%.....	Slight increase
Ozone 10.4–34.8 milligram per 20 cm ³	Marked diminution
Hydrocyanic acid, 1.2%.....	Completely destroyed

Phosphates.—(79).

Sugar, g	Total vol., cm ³	Optimum vol. of 0.6 molar phosphate, cm ³		Maximum rate, cm ³ of CO ₂ /5 min	
		Glucose	Fructose	Glucose	Fructose
2	35	2	5	7.5	32.2
4	50	1	10	5.4	28.4
1.6	23	2	5	8	17
1	25	1.75	5	5.2	25.9
2	25	5	7.5	16.2	31.2
2	20	2	3.5	7.9	22.6
2	22.5	0.75	2	3.4	22.2

Arsenates.—Fermentation of glucose by yeast juice. C_A = concentration of arsenate, mole/l. R_{\max} = maximum rate of fermentation (80); *v. also* (49).

C_A , M/l	R_{\max}	C_A , M/l	R_{\max}
0	3.5	0.00375	34.9
0.04375	6.3	0.0075	29.5
0.0475	8	0.015	23.2
0.0315	14.2	0.0375	14.5
0.033	19.9	0.075	8.7
0.0375	29.7	0.1125	5.3
0.0015	35	0.15	3.2

Arsenate concentration	Rate	
	Glucose	Fructose
0.0075 molar.....	12.1	26.6
0.0225 (opt. for glucose).....	13.4	
0.0525 (opt. for fructose).....		45.8
0.1125.....	5.1	39

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Abderhalden and Brahm, 202, 57: 342; 08. (2) Abderhalden, Caemmerer and Pincussohn, 202, 59: 293; 09. (3) Abderhalden and Fodor, 489, 1: 533; 16. (4) Abderhalden and Fodor, 489, 6: 248; 22. (5) Abderhalden and Michaelis, 202, 52: 326; 07. (6) Abderhalden and Steinbeck, 202, 68: 293; 10. (7) Adler, 205, 77: 146; 16. (8) Anon., Tokyo Igakakai Zasshi, 32: No. 23; 19. (9) Armstrong, 5, 73: 500; 04. (10) Armstrong and Armstrong, 5B, 80: 321; 08. (11) Armstrong and Glover, 5B, 80: 312; 08. (12) Arrhenius, Immunochemie. Anwendungen der physikalischen Chemie auf die Lehre von den physiologischen Antikörpern., Leipzig, Akadem. Verlags., 1907. (13) Bach, 25, 38: 1878; 05. (14) Barendrecht, 7, 49: 456; 04. (15) Barendrecht, 64V, 27: 1113, 1236, 1406; 19. (16) Barton, 1, 42: 620; 20. (17) Bayliss, 5B, 84: 81; 11. (18) Bayliss, The nature of enzyme action, 4th ed. London, Longmans, 1919. (19) Bodenstein, 9, 12: 605; 06. (20) Bourquelot, 14, 3: 287; 15. (21) Bourquelot and Bridel, 6, 28: 145; 13. (22) Bourquelot and Ludwig, 49, 9: 542; 14. (23) Bourquelot and Mougne, 49, 10: 157; 14. (24) Brown, 4, 81: 373; 02. (25) Brown and Glendinning, 4, 81: 388; 02. (26) Brücke, 75, 37: 131; 59. (27) Buchner, Hahn and Hahn, Die Zymase-Gährung. Berlin, Oldenbourg, 1903. (28) Cole, 289, 30: 281; 03. (29) Colin and Chaudun, 34, 167: 208, 338; 18. (30) Colin and Chaudun, 34, 168: 1274; 19. (31) Colin and Chaudun, 34, 169: 849; 19. (32) Colin and Chaudun, 34, 174: 218; 22. (33) Colin and Chaudun, 42, 20: 471; 23. (34) Compton, 5B, 92: 1; 21. (35) Connstein, Hoyer and Wartenberg, 25, 35: 3988; 02. (36) van Dam, 202, 61: 147; 09. (37) Dietz, 202, 52: 279; 07. (38) Donath, 494, 10: 390; 07. (39) Effront, Les enzymes et leurs applications. Carré et Naud, Paris, 1899. (40) Ernström, 202, 119: 190; 22. (41) Euler, 202, 45: 420; 05. (42) Euler, 494, 7: 1; 05. (43) Euler, 202, 51: 213; 07. (44) Euler, Chemie der

- Enzyme*, 11: 121. München, Bergmann, 1920-22. (45) Euler and Blix, 147, 5: No. 23; 19. (46) Euler and Brandting, 205, 97: 113; 19. (47) Euler and Josephson, 25, 56: 446, 453, 1097, 1749; 23. (48) Euler and Laurin, 202, 110: 55; 20. (49) Euler and Lindner, *Chemie der Hefe und der alkoholischen Gärung*. Leipzig, Akadem. Verlags., 1915.
- (50) Euler and Myrbäck, 202, 129: 100; 23. (51) Euler and Svanberg, 202, 112: 192; 20. (52) Euler and Svanberg, 489, 3: 330; 20. 4: 90, 142; 20. (53) Euler and Svanberg, 489, 4: 29; 1920. (54) Evans, 230, 2: 133; 07. (55) Evans, 289, 44: 191; 12. (56) Faltelowitz, *Diss.*, Heidelberg, 1904. (57) Fales and Nelson, 1, 37: 2769; 15. (58) Falk, 1, 35: 601; 13. (59) Falk, 197, 2: 557; 16.
- (60) Falk, 141, 28: 389; 17. (61) Falk, 141, 36: 229; 18. (62) Falk and McGuire, 223, 3: 595; 21. (63) Falk and McGuire, 141, 54: 655; 22. (64) Flohr, 18B, 3: 182; 19. (65) Fuld, 494, 2: 169; 02. (66) Fuld, *Ergeb. Physiol.* I, 1: 468; 02. (67) Giltay and Aberson, *Jahrb. wiss. Botan.*, 26: 543; 94. (68) Goldschmidt, in *BCI*, 5: 445. (69) Groll, 55, 21: 138; 17.
- (70) Groll, 64V, 26: 710; 17. (71) Groll, 18B, 2: 516; 18. (72) Groll, 18B, 9: 520; 24. (73) Gross, *Berl. klin. Wochschr.*, 45: 643; 08. (74) Hahn and Harpuder, 145, 71: 286, 302; 20. (75) Hahn and Michalik, 145, 73: 10; 21. (76) Haley and Lyman, 1: 43: 2664; 21. (77) Hammarsten, 202, 56: 18; 08. 68: 119; 10. 74: 142; 11. 94: 104, 291; 15. 102: 33; 18. 108: 243; 19. 121: 240, 261; 22. 130: 55; 23. (78) Harden, *Alcoholic fermentation*, p. 36, London, Longmans, 1923. (79) *Idem*, p. 120.
- (80) *Idem*, p. 123. (81) Heinicke, *Cornell Agr. Expt. Sta. Mem.*, 62; 19; 23. (82) Helferich, 202, 117: 159; 21. (83) Henri, *Thesis*, Paris, 1903. (84) Henri, 7, 39: 194; 01. 51: 19; 05. (85) Henri and Bancel, 206, 55: 787, 789, 866; 03. (86) Herzog, 202, 37: 149, 383; 03. (87) Herzog, *Z. allgem. Physiol.*, 4: 163; 04. (88) Herzog, *Diss.*, Karlsruhe, 1905. (89) Herzog, 202, 60: 306; 09.
- (90) Herzog and Margolis, 202, 60: 298; 09. (91) Hoyer, 25, 37: 1436; 04. (92) Hudson, 1, 30: 1160, 1564; 08. (93) Hudson and Paine, 1, 31: 1242; 09. (94) Issajew, 202, 42: 102; 04. 44: 546; 05. (95) Jacoby, 205, 1: 53; 06. (96) Jalandar, 205, 36: 435; 11. (97) Josephson, in Euler, *Chemie der Enzyme*. 11: 159. (98) Kanitz, 202, 46: 482; 05. (99) Kastle, Johnston and Elvove, 11, 31: 521; 04.
- (100) Kastle and Loevenhart, 11, 24: 491; 00. (101) Kendall and Sherman, 1, 32: 1087; 10. (102) Kjeldahl, 235, 1: 109; 79. (103) Kjeldahl, 235, 1: 186; 81. (104) Kleinmann and Asada, *Klin. Wochschr.*, 3: 572; 24. (105) Klempin, 205, 10: 204; 08. (106) Laquer, *Diss.*, Breslau, 1905. 494, 7: 273; 05. 277, 55: 240; 06. (107) Ling and Davis, *J. Inst. Brewing*, 8: 475; 02. (108) Lintner and Kröber, 25, 28: 1050; 95. (109) Lövgren, 205, 119: 215; 21.
- (110) Mack and Villars, 1, 45: 501; 23. (111) Falk and McGuire, 1, 45: 1539; 23. (112) Madsen, in (12). (113) Marshall, 141, 17: 351; 14. (114) Mattaur, 70, 39: 495; 20. 40: 65; 21. (115) Michaelis, *Die Wasserstoffionenkonzentration*. Berlin, Springer, 1922. (116) Michaelis and Davidsohn, 205, 30: 481; 11. (117) Michaelis and Davidsohn, 205, 35: 386; 11. (118) Michaelis and Davidsohn, 205, 36: 280; 11. (119) Michaelis and Mendelssohn, 205, 58: 315; 13.
- (120) Michaelis and Menten, 205, 49: 333; 13. (121) Michaelis and Pechstein, 205, 53: 320; 13. (122) Michaelis and Rona, 205, 57: 70; 13. (123) Minami, 205, 39: 392; 12. (124) Nelson and Bloomfield, 1, 46: 1025; 24. (125) Nelson and Griffin, 1, 38: 1109; 16. (126) Nelson and Vosburgh, 1, 39: 790; 17. (127) Nicloux, 206, 56: 840; 04. (128) Noyes, Sugiura and Falk, 1, 46: 1885; 24. (129) Olsson, in Euler, *Chemie der Enzyme*, 11: 114.
- (130) Oppenheimer, *Die Fermente und ihre Wirkungen*. Leipzig, Vogel, 1924. (131) O'Sullivan and Thompson, 4, 57: 834; 90. (132) Pekelharing, 202, 81: 355; 12. (133) Philoche, 42, 6: 212; 08. (134) Philoche, 42, 6: 355; 08. (135) Phragmén, 147, 4: No. 22; 18. (136) Pottevin, *Ann. inst. Pasteur*, 13: 665; 99. (137) Pottevin, 34, 136: 1152; 03. 138: 378; 04. (138) Reichel, *Wiener klin. Wochschr.*, 21: 1085; 08. (139) Reichel and Spiro, 494, 7: 485; 05. 8: 15; 06.
- (140) Ringer, 202, 116: 107; 21. (141) Ringer, 202, 124: 171; 23. (142) Ringer and van Trig, 202, 82: 484; 12. (143) Rockwood, 1, 46: 1641; 24. (144) Rockwood and Huse, 1, 45: 2678; 23. (145) Rona and Bien, 205, 64: 13; 14. 59: 100; 14. (146) Rona and Gabbe, 205, 134: 39; 22. (147) Saito, *Centr. Bakt. Parasitenk.*, 11, 17: 20; 06. (148) Schütz, 202, 9: 577; 85. 30: 1; 00. (149) Schütz and Huppert, 278, 80: 470; 00.
- (150) Senter, 7, 44: 257; 03. (151) Sherman and Neun, 1, 38: 2199; 16. (152) Sherman and Tanberg, 1, 38: 1638; 16. (153) Sherman and Thomas, 1, 37: 623; 15. (154) Sherman, Thomas and Baldwin, 1, 41: 231; 19. (155) Sherman, Thomas and Caldwell, 1, 46: 1711; 24. (156) Sherman and Walker, 1, 39: 1476; 17. (157) Sjögqvist, 202, 47: 307; 05. (158) Sörensen, 205, 21: 131; 09. (159) Spiro, 494, 8: 365; 06.
- (160) Tammann, 7, 3: 25; 89. (161) Tammann, 7, 18: 426; 95. (162) Taylor, *Univ. Calif., Pub. Path.*, 1: 33; 04. (163) Taylor, *quoted in* (130), p. 991. (164) Terroine, 205, 23: 404; 10. (165) van Urk, *Diss.*, Leiden, 1924. (166) Van Laer, 28, 1910: 611, 707. 1911: 84, 362, 795. 1913: 183. (167) Van Slyke and Cullen, 141, 19: 141, 211; 14. (168) Vernon, *Ergebnisse Physiol.*, 9: 138; 10. 289, 27: 174; 01. (169) Visser, 7, 52: 257; 05.
- (170) Weis, 235, 5: 133; 03. (171) Willstätter and Csányi, 202, 117: 172; 21. (172) Willstätter and Kuhn, 202, 115: 180; 21. (173) Willstätter, Oppenheimer and Steibelt, 202, 110: 232; 20. (174) Willstätter and Steibelt, 202, 115: 199; 21. (175) Wohlgemuth, 205, 39: 324; 12.

PHOTOCHEMICAL KINETICS

CHRISTIAN WINTHER

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ABBREVIATIONS AND CONVENTIONS

A Fraction of incident energy absorbed.	A Fraction absorbée de l'énergie incidente.	A Der absorbierte Bruchteil der einfallenden Energie.	A Frazione di energia incidente assorbita.
F Light filter (wave filter).	F Filtre de lumière (filtre d'onde).	F Lichtfilter (Strahlenfilter).	F Filtro di luce.
Fs Spark gap.	Fs Distance explosive.	Fs Funkenstrecke.	Fs Distanza esplosiva.
K _e Equilibrium constant.	K _e Constante d'équilibre.	K _e Gleichgewichtskonstant.	K _e Costante di equilibrio.
K _e = [M] ^m [N] ⁿ /[A] ^a [B] ^b for aA + bB ⇌ mM + nN.	K _e = [M] ^m [N] ⁿ /[A] ^a [B] ^b pour aA + bB ⇌ mM + nN.	K _e = [M] ^m [N] ⁿ /[A] ^a [B] ^b für aA + bB ⇌ mM + nN.	K _e = [M] ^m [N] ⁿ /[A] ^a [B] ^b per aA + bB ⇌ mM + nN.

k_x Velocity constant for reaction of the order x .	k_x Constante de vitesse pour une réaction du $x^{\text{ième}}$ ordre.	k_x Reaktionsgeschwindigkeitskonstante x -ter Ordnung.	k_x Costante di velocità per reazioni di ordine x .
$k_{x,z}$ Velocity constant for x -order reaction in presence of catalyzer or added substance.	$k_{x,z}$ Constante de vitesse pour une réaction du $x^{\text{ième}}$ ordre en présence d'un catalyseur ou d'une substance additionnelle.	$k_{x,z}$ Geschwindigkeitskonstante x -ter Ordnung mit Zusatz.	$k_{x(z)}$ Costante di velocità per reazioni di ordine x in presenza di catalizzatori o di sostanze aggiunte.
p Pressure.	p Pression.	p Druck.	p Pressione.
QQ Quartz mercury vapor lamp.	QQ Lampe de quartz à vapeur de mercure.	QQ Quartz-QuecksilberDampf-lampe.	QQ Lampada di quarzo a vapori di mercurio.
R_λ Range of active wave lengths.	R_λ Intervalle des longueurs d'ondes actives.	R_λ Wirksame Wellenlänge.	R_λ Lunghezze d'onda attive.
Sp Spectral purification of the monochromatic radiation.	Sp Purification spectrale d'une radiation monochromatique.	Sp Spektrale Reinigung der monochromatischen Strahlung (Monochromator).	Sp Separazione spettrale di radiazioni monocromatiche.
[X] Concentration of the substance X in g-mole/liter.	[X] Concentration de la substance X en mol. gr. par litre.	[X] Die Konzentration der Substanz X in g-mol/liter.	[X] Concentrazione della sostanza X in grammi molecole per litro.
Z Catalyzer or added substance.	Z Catalyseur ou substance additionnelle.	Z Ein Katalysator oder Zusatz.	Z Catalizzatore o sostanze aggiunte.
λ Wave length in $\mu\mu$.	λ Longueur d'onde en $\mu\mu$.	λ Die Wellenlänge in $\mu\mu$.	λ Lunghezza d'onda in $\mu\mu$.
α Extinction coefficient. $\alpha = \frac{1}{[X]l} \log_{10} \left(\frac{J_0}{J} \right)$ where l = Length of path in cm.	$\alpha = \frac{1}{[X]l} \log_{10} \left(\frac{J_0}{J} \right)$ où l = Épaisseur de la couche absorbante en cm.	α Extinktionskoeffizient. $\alpha = \frac{1}{[X]l} \log_{10} \left(\frac{J_0}{J} \right)$ wo l = Schichtdicke in cm.	α Coefficiente di estinzione. $\alpha = \frac{1}{[X]l} \log_{10} \left(\frac{J_0}{J} \right)$ dove l = Lunghezza del percorso in cm.
J_0 (resp. J) = Intensity of the incident (resp. emergent) radiation. Bold face numbers following \pm deviation indicate the number of experiments included in the average.	J_0 (resp. J) = Intensité de la radiation incidente (resp. émergente). Les chiffres en caractères gras suivant une déviation \pm indiquent le nombre des valeurs expérimentales dont on a pris la moyenne.	J_0 (bezw. J) = Intensität der einfallenden (bezw. austretenden) Strahlung. Schwarze Ziffern nach eine \pm Abweichung bedeuten die Anzahl Werte, aus welchen der Mittelwert berechnet wurde.	J_0 (resp. J) = Intensità delle radiazioni incidenti o emergenti. I numeri scritti in nero dopo uno scarto \pm indicano il numero delle esperienze dalle quali è stato calcolato il valore medio.

LIGHT FILTERS FOR THE MERCURY VAPOR LAMP

λ , $\mu\mu$	Composition	Thick- ness of layer, cm	Trans- mission		Lit.
			λ	%	
579	0.5 g eosin in 100 cm ³ H ₂ O.....	0.5	579	9.20	(1)
	"Gelbglass" No. 5657*.....	0.1	546	0.07	
	"Gelbglass" No. 5899*.....	0.1	436	0.02	
579	0.25 g eosin in 100 cm ³ H ₂ O.....	0.5	579	30.3	(1)
	"Gelbglass" No. 5657*.....	0.1	546	0.27	
	"Gelbglass" No. 5899*.....	0.1	436	0.14	
579	(a) 2 g quinine in 100 cm ³ N HCl.....	1	436 99 405 0.3 730 1 710 2.2 690 4.9		(4)
	(b) 6 g CuSO ₄ ·5H ₂ O in 100 cm ³ H ₂ O.....	1	670 10.4 650 19.4 630 35.7 610 52.5 590 70.4		
	(c) 0.02 g tartrazin 0.02 g erythrosin in 100 cm ³ H ₂ O.....	1	579 57 546 0 436 0		
	Total filter.....		Red	3.2	

λ , $\mu\mu$	Composition	Thick- ness of layer, cm	Trans- mission		Lit.
			λ	%	
546	0.01 g malachite green in 100 cm ³ H ₂ O.....	0.5	579	3.9	(1)
	"Gelbglass" No. 5657*.....	0.1	546	22.0	
	"Gelbglass" No. 5899*.....	0.1	492 33.8 436 0.02		
546	(a) 2 g quinine in 100 cm ³ N HCl.....	1	436 99 405 0.3 730 1 710 2.2 690 4.9		(4)
	(b) 6 g CuSO ₄ ·5H ₂ O in 100 cm ³ H ₂ O.....	1	670 10.4 650 19.4 630 35.7 610 52.5 590 70.4		
	(c) 0.02 g tartrazin in 100 cm ³ H ₂ O.....	1	436 0		
	(d) "Didymglas" (Schott, Jena).....	1.3	579 1.3 546 84		
	Total filter.....		Red	3.4	
546	0.42 g "Filtergelb" 0.007 g Saubregrün (Höchst) in 100 cm ³ H ₂ O.....	1	546	26	(6)

* Schott, Jena.

LIGHT FILTERS.—(Continued)

λ , $\mu\mu$	Composition	Thick- ness of layer, cm	Trans- mission		Lit.
			λ	ϵ	
492	(a) 1.2 g triphenylmethane in 100 cm ³ C ₂ H ₅ -OH.....	0.55	546 0.046 492 37.4		(3)
	(b) 0.1 g "Cyanolechtgrün G" in 100 cm ³ H ₂ O.....	1.05	436 0.0006 405 0.0008		
436	0.15 g Victoria blue B in 100 cm ³ C ₂ H ₅ OH.....	0.5	579 0.04 546 0.11 492 0.58 436 29.8 405 0.1		(1)
436	0.0075 g rhodamine B } In 6 cm ³ N H ₂ SO ₄ 2 g quinine sulfate } and 94 cm ³ H ₂ O.....	1	436 35 405 Tr. 366 Tr. Also red		(5)
436	(a) 2 g quinine in 100 cm ³ N HCl.....	1	436 99 405 0.3 730 1 710 2.2 690 4.9 670 10.4 650 19.4 630 35.7 610 52.5 590 70.4 579 0 546 0 436 72		(4)
	(b) 6 g CuSO ₄ ·5H ₂ O in 100 cm ³ H ₂ O.....	1	670 10.4 650 19.4 630 35.7 610 52.5 590 70.4 579 0 546 0 436 72		
	(c) 0.003 g acid rhodamine in 100 cm ³ H ₂ O.....	1	579 0 546 0 436 72		
	(d) 0.2 N CuSO ₄ soln. + excess NH ₃	1	Absorbs red and fluores- cent light		
	Total filter.....		405 ca. 0.3 red 0.7		
405	0.12 g "Diamantfuchsin" } In 100 cm ³ 1.2 g triphenylmethane } C ₂ H ₅ OH.....	0.5	579 0.2 546 0.02 405 13.5		(1)
405	0.06 g "Diamantfuchsin" } In 100 cm ³ 1.2 g triphenylmethane } C ₂ H ₅ OH.....	0.5	579 4.5 546 0.13 436 Tr. 405 36.8		(1)
405	0.03 g "Diamantfuchsin" } In 100 cm ³ 4 g quinine hydrochloride } C ₂ H ₅ OH(96%).....	1	436 Tr. 405 34 Also red		(5)
366	0.03 g "Diamantfuchsin" in 100 cm ³ H ₂ O.....	1	366 31 Also red		(5)
313	0.0243 g K ₂ CrO ₄ } In 100 0.00188 g nitrosodimethylaniline } cm ³ H ₂ O.....	1	313 30 302 19 436 Tr. Also red, yellow and some green		(5)

LITERATURE

(For a key to the periodicals see end of volume)

(1) Andrich and Le Blanc, *99*, 15: 183; 15. (2) Le Blanc, Kangro and Andrich, *9*, 25: 229; 19. (3) Vránek, *9*, 23: 336; 17. (4) Warburg and Negelein, *7*, 106: 191; 23. (5) Winther, *9*, 19: 390; 13. (6) Winther, *0*.

VELOCITY OF REACTION

(a) [H₂O₂] = 0.05; F_s; R_λ = 280–210 μμ; retardation constant,

$$K = \frac{k_1(Z) \times 100}{k_1} \quad (7)$$

Z	[Z]	K	Z	[Z]	K
H ₂ SO ₄	2 × 10 ⁻⁴	93	NaOH.....	2 × 10 ⁻²	0
H ₂ SO ₄	4 × 10 ⁻³	66	I ₂	2 × 10 ⁻⁶	60
H ₂ SO ₄	2 × 10 ⁻³	40	HgCl ₂	4 × 10 ⁻⁴	33
H ₂ SO ₄	2 × 10 ⁻²	33	KCN.....	6 × 10 ⁻³	76
H ₂ SO ₄	2 × 10 ⁻¹	33	Na ₂ S ₂ O ₃	2 × 10 ⁻³	26
NaOH.....	2 × 10 ⁻⁴	60	H ₂ S.....	10 ⁻⁶	75
NaOH.....	2 × 10 ⁻³	20	H ₂ S.....	10 ⁻⁴	14

(b) [H₂O₂] = 0.5–0.01; Z = H₂SO₄; QQ; R_λ = 305–316 μμ; titration⁸

[Z]	K	[Z]	K
0.5 × 10 ⁻⁵	67 ± 2.3	0.5 × 10 ⁻³	24 ± 0.7
0.5 × 10 ⁻⁴	58 ± 4.9	0.5 × 10 ⁻²	14 ± 0.6

(c) [H₂O₂] = 0.6–1.2; QQ; unilateral glass filter; 25°C; KMnO₄ titration. The K values in the presence of the additions (Z) are relative to 100 for pure H₂O₂; λ's in μμ; accuracy ± 10% (1).

Z	10 ³ [Z]	K, for λ up to			
		200	265	293	305
Nil.....	0	100	30*	16*	7†
			± 2.3	± 0.0	± 0.4
Acetic acid.....	5	75	100	100	100
Phenylacetic acid.....	1	13	45	80	100
β-Phenylpropionic acid.....	ca. 3	12	40	70	100
Benzoic acid.....	5	9			100
Ethyl acetate.....	5	100	100	100	100
Ethyl benzoate.....	ca. 1	14	50	80	100
Ethyl phenylacetate.....	ca. 1	17	70	85	100
Ethyl cinnamate.....	ca. 0.2	25	45	65	100
Methyl oxalate.....	5	10	20	35	70
Methyl benzoate.....	5	9			
Ethylamine.....	ca. 5	5	0	0	0
Aniline.....	5	7	0	0	0
Benzylamine.....	5	8	0	0	0
Acetamide.....	5	65	100	100	100
Benzamide.....	3	9			
Acetanilide.....	0.1	60	100	100	100
Ethyl alcohol.....	5	35	35	35	35
Phenol.....	2	0	0	0	0
Benzyl alcohol.....	ca. 3.3	8	25	40	40
Acetone.....	5	70	60	55	50
Acetophenone.....	0.2	11	40	65	100
Benzophenone.....	0.1	45	60	100	100
Benzene.....	5	20		70	
Quinine hydrochloride.....	0.2	9	20	10	0
Quinine salicylate.....	0.2	4	0	0	0

* Three experiments. † Four experiments.

(d) [H₂O₂] = 0.6–1.2; QQ; unilateral glass filter; titration; accuracy ± 10%; retardation independent of λ and temp. (2)

Z ₁	10 ³ [Z ₁]	Z ₂	[Z ₂]	K
HClO ₄	5	Nil	0	30
Nil	0	KClO ₄	0.1	100
HClO ₄	5	KClO ₄	0.1	40
HNO ₃	5	Nil	0	30
Nil	0	KNO ₃	0.005	100
Nil	0	NaNO ₃	0.005	100
Nil	0	Ba(NO ₃) ₂	0.005	110
H ₂ SO ₄	0.5	Nil	0	65
Nil	0	Na ₂ SO ₄	1.0	100
H ₂ SO ₄	0.5	Na ₂ SO ₄	1.0	100
H ₂ SO ₄	5	Nil	0	35
Nil	0	Na ₂ SO ₄	3.0	100
H ₂ SO ₄	5	Na ₂ SO ₄	1.0	75
H ₂ SO ₄	5	Na ₂ SO ₄	2.0	100
Nil	0	K ₂ SO ₄	1.5	100
H ₂ SO ₄	5	K ₂ SO ₄	1.5	100
Nil	0	MgSO ₄	2.0	100
H ₂ SO ₄	5	MgSO ₄	2.0	100
H ₂ SO ₄	5	MgSO ₄	1.0	70
Nil	0	(NH ₄) ₂ SO ₄	3.0	100
H ₃ PO ₄	5	Nil	0	40
H ₃ BO ₃	5	Nil	0	100
H ₃ BO ₃	100	Nil	0	100

(d).—(Continued)

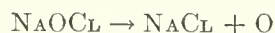
Z ₁	10 ³ [Z ₁]	Z ₂	[Z ₂]	K
NaOH	5	Nil	0	0
NaOH	1	Nil	0	2
NaOH	1	Na ₂ SO ₄	1.0	10
NaOH	1	Na ₂ SO ₄	2.0	30
NaOH	1	Na ₂ SO ₄	3.0	70
NaOH	0.5	Nil	0	14
NaOH	0.5	Na ₂ SO ₄	2.0	60
NaOH	0.5	Na ₂ SO ₄	3.0	100
KOH	5	Nil	0	0
KOH	0.5	Nil	0	16
KOH	0.5	K ₂ SO ₄	1.5	70
Ba(OH) ₂	5	Nil	0	0
NH ₄ OH	5NH ₃	Nil	0	10
NH ₄ OH	5NH ₃	(NH ₄) ₂ SO ₄	3.0	60
C ₂ H ₅ NH ₃ OH	5RNH ₂	Nil	0	5
C ₆ H ₅ CH ₂ NH ₃ OH	5RNH ₂	Nil	0	8

Values of K (2)

10 ³ [Z]					10 ³ [Z]				
Z	5	2	1	0.5	Z	5	2	1	0.5
HCl	20				MgCl ₂	50	75		100
NaF	120				BaCl ₂	40			
NH ₄ Cl	35			100	NH ₄ Br	55	80		100
NaCl	40	70	80	100	KBr	60	85	100	100
KCl	40	75	80	100	BaBr ₂	60			

K for halide (Z₁) and sulfate (Z₂) of the same metal; [Z₁] = 0.005 (2)

$\begin{array}{c} [Z_2] \\ Z_1 \end{array}$						$\begin{array}{c} [Z_2] \\ Z_1 \end{array}$					
0	1	1.5	2	3		0	1	1.5	2	3	
NH ₄ Cl.....	35			45	55	MgCl ₂	50			75	
NaCl.....	40	50		75	100	NH ₄ Br.....	55	60		85	
KCl.....	40	60	70			KBr.....	60	85	100		



Aqueous solution; Uviol lamp, F; 15 ± 1°C; titration with As₂O₃; t in hr (16)

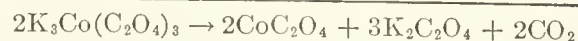
[NaOCl]	[NaCl]	10 ³ k ₁	
0.08	0.0	41.2 ± 0.9	3
0.08	0.34	36.7 ± 0.4	3

[NaOCl] = 0.075; [NaOH] = 0.0053; [Na₂CO₃] = 0.0089

10 ³ [HCl] =	0.0	9.1	17.1	25.3	37.9	49.5
10 ³ k ₁ =	41.8	51.0	48.7	43.0	30.4	25.0

[NaOCl]	[NaOH]	10 ³ k ₁	
0.076	0.0	40.8 ± 0.5	4
0.076	0.143	40.0 ± 0.9	4

[NaOCl]	0.075	0.076	0.013	0.075	0.075	0.013
λ, μm	436	405	405	366	313	313
10 ³ k ₁	3.69	4.04	3.84	4.75	2.16	13.7
±	0.03	0.04	0.14	0.06	0.03	0.02
	5	3	4	4	4	3



Aqueous solution; half-watt lamp or QQ, F; analysis by extinction measurement; in white light *ca.* monomolecular, at high dilutions *ca.* bimolecular (concn. in %); t in min; velocity/intensity = const. variation of intensity, 1/4.73 (17).

(a) With half-watt lamp

[K ₃ CoOx ₃]	°C	10 ⁵ k ₁		$\frac{k_1}{k_{z_1}}$ *	[K ₃ CoOx ₃] = 0.0001 at 12.0°C	
0.02	12.0	97 ± 0.2	2	1.40	[K ₂ C ₂ O ₄]	10 ⁵ k ₁
0.01	12.0	149 ± 0.8	4	1.67	0.0	383
0.005	13.4	249 ± 1.2	4	1.69	0.001	316
0.002	14.5	326 ± 2.0	6	1.85	0.0025	264
0.001	12.2	383 ± 2.5	11	1.81	0.005	232
0.0005	14.7	418 ± 15	9	1.88	0.009	225
0.0002	14.3	426 ± 11.5	15	1.80	0.035	211
0.0001	13.0	612 ± 37	6	1.70	0.080	211
		k_2				
0.0001	13.0	85 ± 4.7	4			
0.0001	10.9	95 ± 4.5	7			

* k_{z₁} corresponds to an addition of 35–80 moles K₂C₂O₄ per mole K₃Co(C₂O₄)₃.

(b) With QQ

[K ₃ CoOx ₃]	°C	10 ⁵ k ₁		[K ₃ CoOx ₃] × 10 ³	Path length, cm
0.01	10.2	250 ± 6	6		1.06 0.52
0.005	10.4	434 ± 5	7		
0.002	9.7	666 ± 4	7		
0.001	11.2	790 ± 22	4		
0.0002	9.8	799 ± 35	7	5	434 521
0.0001	9.5	987 ± 31	6	2	636 776
				1	790 734
				0.1	987 749

(c) With QQ and filter (for filters, see p. 160)

λ, μm	[K ₃ CoOx ₃]	°C	10 ⁵ k ₁		10 ² k ₂	
436	0.005	10.2	93.9 ± 1.0	7	21 ± 0.7	5
	0.002	11.3	75.7 ± 1.4	10	42.7 ± 0.3	6
	0.001	10.9	126 ± 4	11	149 ± 2	9
	0.0002	10.8	88.3 ± 3.3	6	600 ± 50	9
405	0.005	11.4	75.2 ± 3.8	6	16.4 ± 0.7	3
	0.002	10.9	64.5 ± 1.6	11	37.1 ± 0.7	3
	0.001	8.8	92.1 ± 1.5	13	102 ± 1	5
	0.0002	10.0	88.3 ± 2.9	10	522 ± 14	9
366	0.005	10.7	49.7 ± 0.5	9	10.9 ± 0.4	5
	0.002	10.1	49.7 ± 0.5	9	27.7 ± 0.3	6
	0.001	11.5	59.5 ± 1.3	12	63.8 ± 1.5	4
	0.0002	9.4	64.7 ± 1.8	7	380 ± 5	8

ANTHRACENE → DIANTHRACENE

Are lamp, glass vessels, v in g-mole cm⁻² sec⁻¹ with 1 cm² illuminated at 1 cm distance (10)

Solvent	C ₆ H ₆	Toluene	Xylene	Anisole	Phenetole
°C	80	109	137	154	154 160 167
10 ⁷ v	3.42	4.80	4.50	3.10	3.00 3.87 4.42



Catalyzed by ketones; QQ, glass filter; path length 1 mm; 35 ± 0.01°C; measurement of pressure, Δp = cm³ O₂ required per hr; for complete absorption Δp is independent of [Z] (4).

Z	Benzophenone						
[Z]	1	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$
Δp	10.30	12.00	12.00	11.90	9.00	5.60	5.65 2.28

Z	Phenyl cyclohexyl ketone				Phenyl n-hexyl ketone			
[Z]	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	2	1	$\frac{1}{2}$	$\frac{1}{4}$
Δp	5.15	5.00	2.82	1.12	1.00	0.97	0.68	0.22

Z	Acetophenone				Propiophenone			
[Z]	2	$1\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{4}$	2	1	$\frac{1}{2}$
Δp	1.30	1.40	1.42	1.03	0.22	1.10	1.11	0.92 0.20

$C_2H_5OH + O_2$ —(Continued)

Z	Phenyl benzyl ketone			Diphenyl-acetophenone		Phenylacetone		
[Z]	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{32}$	$\frac{1}{64}$	3	2	1
Δp	5.05	4.85	2.35	3.13	0.78	0.50	0.48	0.35
Z	Dibenzyl ketone			asym.-Diphenyl-acetone		Triphenyl-acetone	sym.-Tetra-phenyl-acetone	
[Z]	2	1	$\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$
Δp	1.76	1.75	0.85	0.03	0.01	0.05	0.17	0.17
Z	Phenyl furfuryl ketone			Diacetyl				
[Z]	2	1	$\frac{1}{2}$	4	3	2	$1\frac{1}{2}$	
Δp	0.07	0.10	0.10	16.00	15.30	15.30	15.10	
Z	Diacetyl							
[Z]	1	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	
Δp	14.90	14.10	10.60	6.40	2.60	0.64	0.16	
Z	Benzil			Acetylbenzene				
[Z]	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	4	$3\frac{1}{2}$	3	2	
Δp	3.20	1.44	0.52	8.60	11.70	12.90	12.60	
Z	Acetylbenzene							
[Z]	$1\frac{1}{2}$	1	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	
Δp	12.80	13.10	10.80	8.50	6.05	4.15	2.08	
Z	Furil	Benzofuril			Terephthalophenone			Isophthalophenone
[Z]	$\frac{1}{16}$	2	1	$\frac{1}{2}$	$\frac{1}{16}$	0.01	0.006	0.004
Δp	2.80	5.80	6.30	6.20	2.20	2.80	3.55	3.45
Z	Phenanthrene-quinone			Anthra-quinone	α -Hydrindone			1, 2-Indandione
[Z]	0.02	0.01	0.004	0.004	2	1	$\frac{1}{2}$	$\frac{1}{8}$
Δp	10.50	6.25	0.67	0.67	0.19	0.17	0.07	0.92

The following are inactive: Dicyclohexyl ketone, Di-*n*-hexyl ketone, Triphenylacetophenone, Acetone, Fluorenone, Pentane triketone, Diphenyl triketone, Alloxan.

 $CHI_3 + O_2$

(a) Uviol lamp; quinine filter; active $\lambda = 436$; stirred with O_2 , 22°C; $k = [I_2]/2t$; t in min (12); k_L = direct reaction in light; k_N = after effect in dark.

In benzene								
[CHI ₃]	0.10	0.08	0.06	0.04	0.02	0.02	0.01	0.005
$10^6 k_L$	91.5	85.6	73.3	58.1	38.6	30.9	25.3	15.5
$10^6 k_N$	50.5	37.9	26.7	15.7	6.4	6.2		
In C_2H_5OH ($k_N = 0$)								
$10^6 k_L$		4.56	4.25	4.00	3.12		1.75	0.84
Solvent						$10^6 k_L$	$10^6 k_N$	
CCl ₄						39.4	2.4	
C ₆ H ₆						34.6	5.5	
CS ₂						24.1	0	
CH ₃ CO ₂ C ₂ H ₅						8.1	0.9	
C ₂ H ₅ OH						2.3	0	
95% C ₂ H ₅ OH + 5% H ₂ O						1.29	0	
85.5% C ₂ H ₅ OH + 14.5% H ₂ O						0.61	0	
80% C ₂ H ₅ OH + 20% H ₂ O						0.44	0	
Acetone						0.7	0	

(b) Uviol, F; active $\lambda = 436$; 19°C; benzene solution; effects of catalyzers (13)

Z	[Z]	$10^6 k_L$	$10^6 k_N$
Nil	0	36.9	6.1
NO ₂	66×10^{-7}	34.1	6.9
NaNO ₂	Satd.	44	0
KNO ₃	Satd.	34.6	6.4
K ₂ Cr ₂ O ₇	Satd.	32.2	5.8
Na formate	Satd.	36.6	6.4
Cu acetate	Satd.	38.0	5.0
Na butyrate	Satd.	31.5	6.5

Z	Z per 100 cm ³	$10^6 k_L$	$10^6 k_N$
CHCl ₃	5 cm ³	38.1	7.9
C ₆ H ₅ NO ₂	0.1 cm ³	35.6	7.4
Cinnamic acid	0.025 g	34.6	6.4
C ₆ H ₅ NH ₂	5 cm ³	4.5	0
Nitrosodimethylaniline	0.03125 g	33.0	7.0
Anethole	0.25 cm ³	27	0
Aminoazobenzene	0.035 g	33.1	5.8
Triphenylmethane	0.0025 g	32.5	9.5
Crystal red	0.0025 g	39.6	2.4
Cyanin	0.0325 g	36.2	5.8

DYES + O₂

In collodion; Nernst lamp, Sp; analysis by extinction measurement; $\Delta[Dye]/[Dye] \times t = a + b p_{O_2}$; p_{O_2} = pressure of O₂ in cm Hg; (9); $A_0 = A$ at beginning; t_s = time of exposure, min.

Dye	λ	A_0	t_s	a	b
Cyanin	589	0.71	5	0.0031	0.0331
Pinachrome	580	0.62	5	0.0024	0.0329
"Lepidincyanin"	604	0.18	7	0.020	0.0345

HYDROLYSIS OF ACETONE, ETHYL ALCOHOL AND ACETALDEHYDE

Fs, unilateral filter; aqueous solutions; conductivity measurement; Sen. = $\Delta[X]$ per unit of incident radiation (E) (6)

λ	E	Acetone		Ethyl alcohol		Acetaldehyde	
		α	Sen.	α	Sen.	α	Sen.
360-320	324	<1	0.1		0.7	2.8	1.3
298-288	81	10	21	10	5.3	79	
274.8	113						
257.2	84						
246.9	28						
231.3	753						
228.8	199	3	0.6	7	35	1.2	1.7
226.5	199						
226.5	199						
219.5	339	0.8	0.5	27	116	9	3.8
214.4	256						

 $CH_2ClCOOH + H_2O \rightarrow CH_2OHCOOH + HCl$

QQ, 27°C; analysis as AgCl (resp. AgBr), resp. acid titration (5)

[Acid]	$CH_2ClCOOH$	$CH_2BrCOOH$
1.0	$10^6 k_1 = 10$	28
2.0	$10^6 k_1 = 5$	16.5

HALOGEN ACIDS + C₂H₅OH

Aqueous solution; arc lamp; [acid] = 0.5; 18°C, *t* in min; analysis, as AgCl (resp. AgBr), resp. titration with NaHSO₄ + KI₃ (3)

Vol. % C ₂ H ₅ OH	10% <i>k</i> ₁			
	Cl-acetic	Br-acetic	Cl-succinic	Br-succinic
0	40.3	27	63.6	84.6
25	56.0	485		
50	70.0	947	155.0	258.0
75	70.0	662		
100	71.0	479		

HALOGEN ACIDS + EXCESS KOH

Aqueous solution; QQ, quartz vessels; *t* in hr; Z = 5 drops 5% soln. of CuSO₄ per 50 cm³; A = *p*-bromobenzenesulfonic, B = *p*-bromobenzoic, C = *p*-chlorobenzoic (15).

Acid	°C	In dark + Z		In light		In light + Z	
		10% <i>k</i> ₁		10% <i>k</i> ₁		10% <i>k</i> ₁	
A	107	3.71 ± 0.28	4	36.9 ± 0.2	3	70.3 ± 3.3	4
B	103-105	1.46 ± 0.24	2	78.8 ± 2.7	3	101.3 ± 31	3
C	104-105	0		17.86 ± 0.18	4	18.21 ± 0.28	4

C₂H₅OH + (NH₄)₂CrO₄ (RESP. (NH₄)₂Cr₂O₇)

Aqueous solution; Uviol lamp, F for λ = 436; 20°C; titration; *k* = Δ[chromate] × 10³/*t*(hr) (14)

[(NH ₄) ₂ Cr ₂ O ₇] = (8.3-8.7) × 10 ⁻³		[C ₂ H ₅ OH] = 64%	
[C ₂ H ₅ OH]	10% <i>k</i>	[(NH ₄) ₂ Cr ₂ O ₇]	10% <i>k</i>
87%	36	161.5 × 10 ⁻³	40
64%	23	25.1 × 10 ⁻³	35
48%	16	16.1 × 10 ⁻³	30
32%	9.5	8.45 × 10 ⁻³	21
8.1%	4.8		

[(NH ₄) ₂ CrO ₄] = (8.4-8.7) × 10 ⁻³		[C ₂ H ₅ OH] = 64%	
[C ₂ H ₅ OH]	10% <i>k</i>	[(NH ₄) ₂ CrO ₄]	10% <i>k</i>
87%	39	84.58	53
80%	34	48.01	44
64%	24	25.22	29
32%	3.35	17.02	25
8.1%	3.1	4.42	9.6

H₂ + S → H₂S

QQ, active λ = 280-270μμ; Δ[H₂S] in g/sec × 10³; *p* = partial pressure of sulfur vapor (11)

<i>p</i> = 6.3 mm Hg		320°C		
°C	Δ[H ₂ S]	<i>p</i> , mm	Δ[H ₂ S]	Δ[H ₂ S]/ <i>p</i>
300	8.99	5.25	11.6	2.22
310	13.37	6.30	16.4	2.60
320	17.45	7.60	17.4	2.29
330	24.83	9.10	20.7	2.27
340	34.39			

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Anderson and Taylor, *1*, 45: 650; 23. (2) Anderson and Taylor, *1*, 45: 1210; 23. (3) Cassel, *7*, 92: 113; 16. (4) Cohen, *64P*, 26: 443; 23. (5) Euler and Cassel, *7*, 84: 371; 13. (6) Henri and Wurmser, *34*, 156: 230; 13. (7) Henri and Wurmser, *34*, 157: 284; 13. (8) Kornfeld, *99*, 21: 66; 21. (9) Lasareff, *7*, 78: 657; 12. (10) Luther and Weigert, *7*, 53: 385; 05. (11) Norrish and Rideal, *4*, 125: 2070; 24. (12) Plotnikow, *7*, 75: 337, 385; 11. (13) Plotnikow, *7*, 76: 743; 11. (14) Plotnikow, *99*, 19: 40; 19. (15) Rosenmund, Luxat and Tiedemann, *25*, 56: 1950; 23. (16) Spence, *4*, 105: 2565; 14. (17) Vránek, *9*, 23: 336; 17.

TEMPERATURE COEFFICIENTS

Except in the case of the reaction, NH₃ → N + 3H, all known temperature coefficients refer only to the incident (not the absorbed) light. Possible changes in absorption with temperature are therefore not taken into account.

A = arc lamp; B = blue; D = in dark; Da = daylight; DB = dark blue; G = green; Gl = incandescent lamp; Mf = metal filament; Or = orange; R = red; S = sunlight; T = tungsten arc lamp; UV = ultraviolet; V = violet; W = white.

Substance (process)	Radiation	θ ₁ , θ ₂ , °C	<i>k</i> _{θ+10} / <i>k</i> _θ	Lit.
Gases				
H ₂ + O → H ₂ O.....	UV > 220	150-240	1.04	(18)
		131-191	1.12	(3)
		130-194	1.11	(3)
		191-228	1.06	(3)
H ₂ O → H ₂ + O.....	UV > 220	8-20	1.137	(56)
H ₂ + S* (QQ).....	280-270 D	300-340	1.37	(40)
		300-340	1.48	(40)
2O ₃ → 3O ₂ (+Cl ₂).....	W-Mf	16-25.2	1.17	(59)
H ₂ + Cl ₂ → 2HCl.....	W-Mf	10-20	1.14	(9)
		20-30	1.17	(9)
		30-40	1.23	(9)
		40-50	1.25	(9)
		50-60	1.23	(9)
		10-20	1.27	(42)
		20-30	1.15	(42)
		30-40	1.45	(42)
		10-20	1.50	(42)
		20-30	1.50	(42)
	G 550-530	30-40	1.56	(42)
		10-20	1.29	(42)
		20-30	1.34	(42)
	B 490-470	30-40	1.31	(42)
		10-20	1.22	(42)
		20-30	1.21	(42)
	V 460-440	30-40	1.20	(42)
		10-20	1.19	(42)
		20-30	1.15	(42)
	UV 400-350	30-40	1.17	(42)
H ₂ + Cl ₂ → 2HCl(+I ₂).....	W	0-20	1.091	(41)
		20-40	1.028	(41)
		0-10	1.133	(41)
	G	10-20	1.147	(41)
		20-30	1.250	(41)
		30-40	1.240	(41)
	B	0-20	1.107	(41)
		20-30	0.939	(41)
		30-40	0.882	(41)
	V	0-20	1.084	(41)
		20-30	0.919	(41)
		30-40	0.868	(41)
H ₂ + Br ₂	W-T	160-218	1.58 ± 0.13	(11)
	D	224.7-301.3	2.09 ± 0.08	(10)
HI → H + I.....	UV	150-175	1.00	(12)
Cl ₂ O → Cl ₂ + O.....	V	10-40	1.09	(13)
SO ₂ + O → SO ₃	UV > 220	50-160	1.2	(17)
SO ₂ + Cl ₂ → SO ₂ Cl ₂	UV > 220	18-99	0.88	(57)
NH ₃ → N + 3H.....	214-202.5	10-20	1.00	(32)
		20-100	1.05	(33)
		100-200	1.04	(33)
		200-300	1.05	(33)
		300-400	1.06	(33)
		400-500	1.04	(33)
NOCl → NO + Cl.....	W	0.1-78	1.0	(30)
Aqueous solutions				
H ₂ O ₂ → H ₂ O + O.....	UV	10-30	1.43	(2)
		21-35.5	1.15	(56)
		35-45	1.45	(38)
		21.4-34.3	1.54	(38)
	UV > 254		1.32	(31)
Cl ₂ + H ₂ O → HClO + HCl..	UV > 220	15-30	1.40 ± 0.02	(6)
NaOCl → NaCl + O.....	UV > 254	10-24	1.06 ± 0.01	(55)
NaNO ₂ + I ₂	W-S	25-35	1.1	(4)†
	D	40-60	2.8	(4)†

Aqueous solutions.—(Continued)

Substance (process)	Radiation	$\theta_1, \theta_2, ^\circ\text{C}$	$k_{\theta+10}/k_{\theta}$	Lit.
$\text{Fe}^{+++} + \text{I}^- \rightarrow \text{Fe}^{++} + \text{I}$ (displacement of equilibrium)...	579	25–35	1.17	(53)
$\text{Fe}^{+++} + \text{I}^- \rightarrow \text{Fe}^{++} + \text{I}$	D	25–35	2.71	(53)
$\text{CCl}_3\text{CO}_2\text{H} + \text{H}_2\text{O}$	W-S	75–85	1.92	(4)†
	D	80–90	4.28	(4)†
Lactic acid + $\text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{C}_2\text{H}_5\text{OH}$	UV	30–75	1.04	(24)
$\text{C}_2\text{H}_5\text{OH} + (\text{NH}_4)_2\text{CrO}_4$	436	20–30	1.02 ± 0.02	(51)
$\text{C}_2\text{H}_5\text{OH} + (\text{NH}_4)_2\text{Cr}_2\text{O}_7$	436	20–30	0.99 ± 0.05	(51)
Na formate + I_2	W-S	30–40	ca. 2.6	(22)
	D	{ 25–35 25–50	4.01 3.89	(20) (20)
Na formate + HgCl_2	W-S	30–40	ca. 2.3	(22)
	D	{ 25–40 40–50	4.03 3.63	(20) (20)
$\text{C}_2\text{H}_2\text{O}_4 + \text{CrO}_3 + \text{MnSO}_4$...	W-S	10–20	ca. 1.3	(22)
	D	0–20	2.98	(20)
$\text{C}_2\text{H}_2\text{O}_4 + \text{KMnO}_4 + \text{MnSO}_4$	W-S	10–20	ca. 1.1	(22)
	D	0–20	3.21	(52)
$\text{C}_2\text{H}_2\text{O}_4 + \text{FeCl}_3$	W-S	{ 3–44 21–61	1.02 ± 0.02 1.01	(35) (7)
	D	40–62.1	5.26	(34)
$(\text{NH}_4)_2\text{C}_2\text{O}_4 + \text{HgCl}_2$	W-S	0–8	1.07	(23)
		8–15	1.08	(23)
		15–25	1.12	(23)
		25–30	1.24	(23)
		30–40	1.27	(23)
		40–48	1.23	(23)
		48–60	1.37	(23)
		60–80	1.29	(23)
		80–100	1.91	(23)
		20–30	1.28 ± 0.05	(44)
	W-A	30–40	1.33 ± 0.07	(44)
	B 478–410	20–40	1.22 ± 0.05	(44)
	UV 400–280	20–40	1.13 ± 0.06	(44)
$(\text{NH}_4)_2\text{C}_2\text{O}_4 + \text{HgCl}_2$ (+eosin)	W-A	{ 20–30 30–40	1.65 ± 0.07 1.29 ± 0.11	(44) (44)
	G 540–505	20–40	1.77 ± 0.03	(44)
$\text{K}_2\text{C}_2\text{O}_4 + \text{HgCl}_2$	D	79.6–99.6	2.24	(21)
$\text{K}_2\text{C}_2\text{O}_4 + \text{I}_2$	R	25–40	3.10	(8)
	B	25–40	3.04	(8)
	D	{ 25–40 40–50 50–60	7.2 6.1 5.4	(8) (20) (20)
$\text{K}_2\text{C}_2\text{O}_4 + \text{Br}_2$	W-Gl	0–15	1.98	(8)
	D	0–11.5	5.99	(8)
$\text{C}_2\text{H}_2\text{O}_4 + \text{HIO}_4$	W-S	33–43	2.4	(4)†
	D	{ 29–59 59–69	3.19 2.98	(4)† (4)†
K cobaltioxalate.....	W	11.9–21.9	1.06	(58)
	D	60.1–67.2	4.6	(58)
$\text{C}_2\text{H}_2\text{O}_4 + \text{uranyl salt}$	W-S	4–40	1.0	(15)
$\text{C}_2\text{H}_2\text{O}_4 + \text{uranyl sulfate}$	UV	{ 25–35 35–45	1.07 1.05	(1) (1)
Tartaric acid + Br_2	B	24.3–34.3	1.7–2.0	(25)
Mandelic acid + TiCl_4	Da	10–27	2.2	(5)
Quinine + CrO_3	UV > 254	23–65	1.04	(28)
	D	25–60	1.88	(21)
Levulose.....	UV > 220	40–70	1.035	(7)
Cane sugar + H_2O	W-S	30–40	1.79–1.18	(4)†
	D	30–40	3.82	(4)†
Tetanus toxin.....	UV > 220	0–24	ca. 1.0	(16)

Other solutions

$\text{CHI}_3 + \text{O}_2$: (In C_6H_6).....	UV > 254	6–51.3	1.42 ± 0.06	(49)
(In $\text{C}_2\text{H}_5\text{OH}$).....	UV > 254	20.5–40.1	1.415 ± 0.015	(49)
Cinnamic acid + Cl_2 (in CCl_4)	UV > 254	8–31	1.402 ± 0.002	(39)
Cinnamic acid + Br_2 (in CCl_4)	UV > 254	1.5–19	1.42 ± 0.01	(50)
	W	32–42	2.0	(26)
Cinnamic acid + Br_2 (in C_6H_6)	UV > 254	6–19	1.37 ± 0.01	(50)
$\text{C}_6\text{H}_6 + \text{Br}_2$	UV > 254	6–19	1.40 ± 0.01	(50)

Other solutions.—(Continued)

Substance (process)	Radiation	$\theta_1, \theta_2, ^\circ\text{C}$	$k_{\theta+10}/k_{\theta}$	Lit.
Toluene + Br_2	UV > 254	1–14	1.9	(14)
		18–33	1.8	(14)
		1–33	2.0	(14)
		0–10	4.8	(14)
		10–25	5.6	(14)
	D	25–33	3.9	(14)
Stilbene + Br_2 (in CCl_4).....		23–33	2.6	(26)
		33–43	2.5	(26)
Alloinnamylideneacetic acid + I_2 (in CCl_4).....	W	24–34	1.75	(27)
Benzophenone + $\text{C}_2\text{H}_5\text{OH}$	W-S	26.5–76.5	1.063 ± 0.003	(19)
<i>o</i> -Chlorobenzophenone + $\text{C}_2\text{H}_5\text{OH}$	W-S	26.5–76.5	1.101 ± 0.007	(19)
Anthracene \rightarrow Dianthracene (in phenetole).....	UV-A	154–167	1.47	(37)
β -Methylanthracene (in C_6H_6)	UV > 220	70–80	1.10	(60)
β -Methylanthracene (in toluene).....	UV > 220	80–105	1.025 ± 0.025	(60)
Di- β -methyldianthracene (in phenetole).....	D	{ 150–160 160–170	2.74 2.60	(60) (60)
Styrene \rightarrow Metastyrene (liquid)	W-S	3–35	1.34	(38)

* Partial pressure of sulfur vapor = 6.3 mm.

† These values have been calculated from the velocity constant for the combined dark and light reaction and for the reaction in the dark.

FADING OF DYES

Substance (process)	Radiation	$\theta_1, \theta_2, ^\circ\text{C}$	$k_{\theta+10}/k_{\theta}$	Lit.
Cyanin (in collodion)....	{ 600 560	19.0–91.2	1.036 ± 0.004	(54)
Pinachrome (in collodion)	{ 600 580	19.5–88.7	1.084 ± 0.0002	
Pinaverdol (in collodion).....	{ 600 580	16.6–58.0	1.067 ± 0.0002	
Pinacyanol (in collodion).....	{ 600 580	18.3–79.2	1.079 ± 0.0005	
Pinaverdol (in collodion).....	570	18.2–69.5	1.069 ± 0.0001	(48)
Pinacyanol (in collodion).....	610	19.1–62.8	1.038 ± 0.0001	
New methylene blue (in glycerol).....	Or	19–81	1.6	
Fluorescent blue (in glycerol).....	Or	19–81	1.6	
Uranin (in glycerol)....	Or	19–81	1.00	(29)
Eosin (in glycerol).....	Or	15–105	1.00	
Visual purple (solution).	W-Gl	7–36	1.0	(29)

PHOTOTROPIC TRANSFORMATION (SOLIDS)

Substance (process)	Radiation	$\theta_1, \theta_2, ^\circ\text{C}$	$k_{\theta+10}/k_{\theta}$	Lit.
Triphenylfulgide (coloration)	G	{ 25–35 35–45	1.65 1.68	(47)
	DB	18–28	1.32	
		28–38	1.31	
		38–48	1.40	
Triphenylfulgide (decoloration)	718–639	23–33	1.08	(47)
	614–574	{ 28–38 38–48	0.92 0.87	
Benzaldehydephenylhydrazon (coloration)	DB	{ 20–30 30–40	1.08 1.16	(47)
	V	14–20	1.02	
		20–40	1.05	
	W-S	40–50	1.06	
		–80–0	1.067	(43)
Benzaldehydephenylhydrazon (decoloration)	D	60–70	1.7	(43)
		80–90	1.71	
		90–100	1.69	
		100–110	1.72	

PHOTOTROPIC TRANSFORMATION.—(Continued)

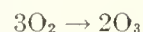
Substance (process)	Radiation	$\theta_1, \theta_2, ^\circ\text{C}$	$k_{\theta+10}/k_\theta$	Lit.
Benzyl- <i>o</i> -tolylsazone (coloration)	W-S	15–25	1.05	(47)
		25–35	1.04	
		35–45	1.07	
	DB	15–25	1.11	
		25–35	1.13	
Piperyl- <i>o</i> -tolylsazone (coloration).....	W-S	–90––10	1.06 ± 0.01	(45)
Piperyl- <i>o</i> -tolylsazone (decoloration).....	D	–10–+10	2	(45)
Salicylidene- β -naphthylamine (coloration)	W-S	0–10	1.43 ± 0.04	(43)
		40–50	1.80	
	G	50–60	1.80	(46)
		60–70	1.75	
	B	40–60	1.45	
	V	50–60	1.39	
Salicylidene- β -naphthylamine (decoloration).....	D	90–110	2.0	(43)
Na diacetyl-di- <i>p</i> -diaminostilbene-di- <i>o</i> -disulfonate (coloration).....	W-S	–10–+20	1.07	(46)
Na diacetyl-di- <i>p</i> -diaminostilbene-di- <i>o</i> -disulfonate (decoloration).....	D	–10–+20	ca. 1.65	(46)

LITERATURE

(For a key to the periodicals see end of volume)

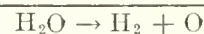
- (1) Anderson and Robinson, *1*, 47: 718; 25. (2) Anderson and Taylor, *1*, 45: 1210; 23. (3) Andrejeff, *53*, 43: 1342; 11. *9*, 19: 551; 13. (4) Banerji and Dhar, *93*, 134: 172; 24. (5) Benrath and Obladen, *99*, 22: 65; 22. (6) Benrath and Tüchel, *99*, 13: 383; 14. *14*: 238; 15. *cf.* Dawson, *99*, 14: 213; 15. (7) Berthelot, *34*, 160: 441; 15. (8) Berthoud and Bellenot, *37*, 7: 307; 24. *42*, 21: 308; 24. (9) Bevan, *201*, 12: 398; 04. (10) Bodenstein and Lind, *7*, 57: 168; 07. (11) Bodenstein and Lütkemeyer, *7*, 114: 208; 24. (12) Bodenstein and Lieneweg, *7*, 119: 123; 26. (13) Bodenstein and Kistiakowski, *7*, 116: 371; 25. (14) Bruner and Czarnecki, *165*, 1910 A: 516. (15) Bruner and Kozak, *9*, 17: 354; 11. (16) Cernovodeanu and Henri, *34*, 149: 365; 09. (17) Coehn and Becker, *7*, 70: 88; 09. (18) Coehn and Grote, *Nernst Festschrift*, 136; 13. *See also* Grote, *Diss.*, Göttingen, 1912. *cf.* Weigert, *25*, 46: 815; 13. (19) Cohen, *70*, 39: 243; 20. (20) Dhar, *4*, 111: 707; 17. (21) Dhar, *14*, 11: 130; 19. (22) Dhar, *4*, 123: 1856; 23. (23) Eder, *75*, 80: 636; 79. (24) Euler and Ryd, *205*, 51: 97; 13. (25) Ghosh and Mukherjee, *482*, 2: 165; 25. (26) Ghosh and Purkayestha, *482*, 2: 261; 25. (27) Ghosh and Gupta, *482*, 2: 241; 25. (28) Goldberg, *99*, 4: 61; 06. (29) Hecht, *223*, 3: 285; 20. (30) Kiss, *70*, 42: 665; 23. (31) Kornfeld, *99*, 21: 66; 23. (32) Kuhn, *34*, 177: 956; 23. (33) Kuhn, *34*, 178: 708; 24. (34) Lemoine, *6*, 30: 289; 93. (35) Lemoine, *6*, 6: 433; 95. (36) Lemoine, *34*, 129: 719; 99. (37) Luther and Weigert, *7*, 51: 297; 05. *53*: 385; 05. (38) Mathews and Curtis, *50*, 18: 166; 11. (39) von Nasaroff, *53*, 47: 943; 15. *99*, 18: 231; 19. (40) Norrish and Rideal, *4*, 125: 2070; 24. (41) Padua, *36*, 51 I: 193; 21. (42) Padua and Butironi, *22*, 25 II: 215; 16. *36*, 47: 6; 17. (43) Padua and Minganti, *22*, 22 II: 500; 13. *36*, 45 I: 15; 15. (44) Padua and Minganti, *22*, 24 II: 97; 15. (45) Padua and Tabellini, *22*, 21 II: 188; 12. *36*, 45 I: 10; 15. (46) Padua and Zazzaroni, *22*, 24 I: 828; 15. (47) Padua and Zazzaroni, *22*, 25 I: 808; 16. (48) Perrin, *34*, 177: 665; 23. (49) Plotnikow, *7*, 75: 337, 385; 11. (50) Plotnikow, *7*, 78: 573; 12. (51) Plotnikow, *99*, 19: 40; 19. (52) Purkayestha and Dhar, *93*, 121: 1561; 22. (53) Rideal and Williams, *4*, 127: 258; 25. (54) Schwesow, *99*, 9: 65; 10. (55) Spence, *4*, 105: 2565; 14. (56) Tian, *16*, 5: 248; 16. (57) Trautz, *9*, 21: 329; 13. (58) Vránek, *9*, 23: 336; 17. (59) Weigert, *9*, 14: 591; 08. (60) Weigert and Krüger, *7*, 85: 579; 13. *86*: 383; 14. *cf.* Krüger, *Diss.*, Berlin, 1913.

DISPLACEMENT OF EQUILIBRIUM



Al-Fs; pressure measurement (5)

$^\circ\text{C}$	20	40	54
Equilibrium at, % O_3	3.4	3.15	2.7



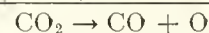
QQ, active: ultra-violet >220; gas at rest; gasometric measurement (1)

$^\circ\text{C}$	150	150	150	150	240
Initial p , atm.....	0.825	0.585	0.448	0.370	0.825
% decomposition.....	0.1237	0.1992	0.2960	0.3618	0.1240
$10^{11} K_c$	2.23	6.65	16.8	28.3	1.84

FORMATION AND DECOMPOSITION OF HALOGEN ACIDS

QQ, gas at rest; iodomet. and acidimet. titration (3)

Process	λ	Initial p , atm.	$^\circ\text{C}$	K_c
$\text{HI} \rightarrow \text{H} + \text{I}$	>220	0.97–0.985	13.2–14.0	35.8
$\text{H} + \text{I} \rightarrow \text{HI}$	>220	0.4		23.10
	>220	0.66		33.45
	>220	1		54.26
	>220	1.33		60.30
	>254	0.985	13.2	∞
	>300	0.99	12.2	∞
$\text{HBr} \rightarrow \text{H} + \text{Br}$	>220	0.99–1	12–19	∞
	>254	1	ca. 18	ca. 0.2
	>300	1	ca. 18	0
$\text{HCl} \rightarrow \text{H} + \text{Cl}$	>220	1		5.4×10^{-6}
	>254	1		0
	>300	1		0

QQ, $\lambda = 254$ –220; gas at rest; 240°C ; $\alpha = 33.31$ –0.0194 p_{CO_2} (2)

p_{CO_2} , mm.....	1397	818	325	94.7
$\alpha = \% \text{ decomposition}$	6.06	17.06	27.39	31.60
$10^5 K_c$	0.54	8.50	17.43	8.62

FUMARIC ACID (F) \rightleftharpoons MALEIC ACID (M)

(a) Fs; stirring; conductivity measurement; values computed from velocity measurements (6)

λ	[F + M]	0.0102	0.00306
		% M at equilibrium	
207		76.4	68.3
253		69.6	63.5
282		80.6	76.0
		75.5	69.3

(b) QQ, glass or quartz vessels; 45 – 50°C (4)

[F + M].....	0.02	0.04	0.05	0.2
% M at equilibrium.....	72.1	74.2	74.7	79

LITERATURE

(For a key to the periodicals see end of volume)

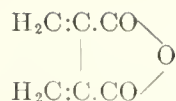
- (1) Coehn and Grote, *Nernst Festschrift*, 136; 13. *See also* Grote, *Diss.*, Göttingen, 1912. *cf.* Weigert, *25*, 46: 815; 13. (2) Coehn and Sieper, *7*, 91: 347; 16. (3) Coehn and Stueckardt, *188*, 1916: 99. (4) Kailan, *7*, 87: 333; 14. (5) Regener, *8*, 20: 1033; 06. (6) Warburg, *76*, 1919: 960.

PHOTOTROPY

A comprehensive review with a list of substances studied is given in (34).

The following classes of compounds show phototropy (in absence of light designated by (D); on exposure to light by (L)):

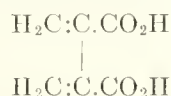
Fulgides (32, 33, 36)



Diaryl derivatives: yellow to orange (D); orange to dark brown (L).

Triaryl derivatives: orange to red (D); dark brown (L).

Fulgenic acids, their salts and esters (36):



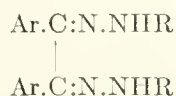
White to pale yellow (D); yellowish green, yellow or orange (L).

Hydrazones (7, 8, 13, 15, 16, 17, 18, 21, 24, 36)



White to yellowish white (D); rose to purple-red (L).

Osazones (1, 14, 19, 20)



Stilbene derivatives (35).

For other organic compounds showing phototropy, see (3, 5, 9, 10, 11, 22, 25, 26, 27, 28, 29, 30, 34, 37, 38).

INORGANIC COMPOUNDS

	(D)	(L)	Lit.
Lithopone.....	white	gray	(2, 23)
CaS, SrS.....	white	rose to violet	(12)
Li ₂ NH.....	white	red	(4)
SnI ₂	red	yellow	(6)

SOLUTIONS IN CHCl₃ (31)

	(D)	(L)
α -Naphthylaminoeamphor.....	colorless	green
<i>m</i> -Phenylenebisaminoeamphor.....	colorless	green
<i>ar</i> -Tetrahydro- α -naphthylaminoeamphor.....	pale red	green

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Biltz, 7, 30: 527; 99. 13, 305: 165; 99. See also Biltz and Wienands, 13, 308: 1; 99. (2) Cawley, 135, 63: 88; 91. (3) Chancel, 34, 96: 1466; 83. (4) Dafert and Miklauz, 57, 33: 63; 12. (5) Deichsel, quoted by Stobbe, 221, 74: 161; 22. (6) Freundler and Laurent, 34, 179: 1049; 24. (7) Graziani, 22, 19 II: 190; 10. (8) Graziani, 22, 22 I: 623; 13. (9) Hantzsch, 25, 40: 1533; 07.
- (10) Heilbron, Hudson and Huish, 4, 123: 2273; 23. (11) ter Meer, 13, 181: 1; 76. (12) Mourelle, 149, 25: 15; 08. 132, 10 I: 231; 12. 34, 158: 122; 14. 160: 174; 15. 161: 172; 15. (13) Padoa, 22, 18 I: 694; 09. (14) Padoa and Bovini, 22, 20 II: 712; 11. (15) Padoa and Graziani, 22, 18 II: 269; 09. (16) Padoa and Graziani, 22, 18 II: 559; 09. (17) Padoa and Graziani, 22, 19 I: 489; 10. (18) Padoa and Graziani, 22, 19 II: 193; 10. (19) Padoa and Santi, 22, 19 II: 302; 10.
- (20) Padoa and Santi, 22, 20 I: 675; 11. (21) Padoa and Santi, 22, 20 II: 196; 11. (22) Peuckert and Siegel, quoted by Stobbe, 221, 74: 161; 22. (23) Phipson, 34, 93: 387; 81. 135, 44: 138; 81. 45: 61; 82. (24) Santi, 22, 20 II: 228; 11. (25) Schönborg, Diss., Leipzig, 1913, p. 103. (26) Senier and Clarke, 4, 105: 1917; 14. (27) Senier and Forster, 4, 105: 2462; 14. (28) Senier and Shephard, 4, 95: 441; 09. (29) Senier and Shephard, 4, 95: 1943; 09.
- (30) Senier, Shephard and Clarke, 4, 101: 1950; 12. (31) Singh, 1, 43: 333; 21. 482, 1: 45; 24. (32) Stobbe, 13, 359: 1; 08. (33) Stobbe, 13, 380: 1; 11. (34) Stobbe, 221, 74: 161; 22. (35) Stobbe and Mallison, 25, 46: 1226; 13. (36) Thormann, Diss., Leipzig, 1912. (37) von Walther, 52, 67: 445; 03. (38) Wilson, Heilbron and Sutherland, 4, 105: 2892; 14.

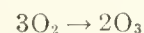
QUANTUM SENSITIVITY

Additional Abbreviations

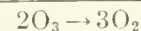
B	Bolometer.	B	Bolomètre.
E_A	Energy absorbed, erg cm ⁻² sec ⁻¹ .	E_A	Énergie absorbée, erg cm ⁻² sec ⁻¹ .
E_T	Total energy absorbed by the system, erg sec ⁻¹ .	E_T	Énergie totale absorbée par le système, erg sec ⁻¹ .
Gl	Incandescent lamp.	Gl	Lampe à incandescence.
Sk	Radiation calorimeter.	Sk	Calorimètre à radiation.
Ts	Thermopile.	Ts	Pile thermoélectrique.
n	Quantum sensitivity.	n	Sensibilité au quantum.
$n = \Delta[X]N h\gamma/E_A$, where N = Avogadro's number, h = Planck's constant, γ = frequency.		$n = \Delta[X]N h\gamma/E_A$, où N = nombre d'Avogadro, h = constante de Planck, γ = fréquence.	

B	Bolometer.	B	Bolometro.
E_A	Die absorbierte Energie, erg cm ⁻² sec ⁻¹ .	E_A	Energia assorbita, erg cm ⁻² sec ⁻¹ .
E_T	Totale Energie bei dem System absorbiert, erg sec ⁻¹ .	E_T	Energia totale assorbita dal sistema, erg sec ⁻¹ .
Gl	Glühlampe.	Gl	Lampada a incandescenza.
Sk	Strahlungskalorimeter.	Sk	Radioealorimetro.
Ts	Thermosäule.	Ts	Termopila.
n	Quantenempfindlichkeit.	n	Sensibilità per un quanto.
$n = \Delta[X]N h\gamma/E_A$ wo N = die Avogadro'sche Zahl, h = die Plancksche Konstante, γ = die Frequenz.		$n = \Delta[X]N h\gamma/E_A$, dove N = numero di Avogadro, h = costante di Planck, γ = frequenza.	

GAS REACTIONS



p , kg/cm ²	λ	$10^{-2}E_T$	A	n	N^*	Remarks	Lit.
95-150	203-214	47-182	0.95-0.99	1.67		Fs, Sp, B	(47)
98-131	209	85-174	0.95-0.98	1.87 ± 0.03	12	Fs, Sp, B. Bomb O ₂	(49)
115-135	209	86-117	0.933-0.956	1.74 ± 0.05	6		
300	209	98-115	0.978	1.52 ± 0.02	4		
110-143	253	90-127	0.437-0.589	1.09 ± 0.07	6		
124-139	253	85-103	0.378-0.457	1.09 ± 0.04	3		
300	253	157-196	0.88	0.57 ± 0.04	4		
136-146	209		0.88-0.98	1.85 ± 0.04	3	Fs, Sp, B. 33-95 vol. % O ₂ , 67-5 vol. % N ₂ , 21 vol. % O ₂ , 79 vol. % N ₂	(50)
293.5	209		0.94	1.30			
47.5	207	64-111	0.636	1.06 ± 0.03	7	Fs, Sp, B. Streaming gas	(54)
47.5	207	68-92	0.636	1.00 ± 0.01	8		
47.5	207	76-102	0.636	1.06 ± 0.02	8		
97	253	85-101	0.317	0.56 ± 0.02	3		
97	253	86-116	0.311	0.59 ± 0.02	4		
97	253	92-185	0.526	0.70 ± 0.04	2		



Vol. % O ₃	Vol. % O ₂	λ	$10^{-2}E_T$	A	n	N^*	Remarks	Lit.
9.29	90.71	250-256	115	1	3.48		Fs, Sp, B. Streaming gas	(48)
2.92	97.08	250-256	84	0.95	1.65			
1.85	98.15	250-256	95	0.98	0.76			
0.75	99.25	250-256	102	0.94	0.49			
0.47-0.18	99.53-99.82	250-256	67-188	0.752-0.248	0.28 ± 0.01	4		
Vol. % O ₃	Vol. % N ₂							(41)
2.56	97.44	250-256	108	0.98	2.64			
1.41	98.59	250-256	232	0.93	1.89			
0.65-0.167	99.35-99.833	250-256	61-215	0.877-0.267	1.08 ± 0.05	13		
Vol. % O ₃	Vol. % He							(48)
0.429	99.571	250-256	108	0.804	1.78			
0.361	99.639	250-256	104	0.710	1.60			
Vol. % O ₃	Vol. % O ₂							(48)
8.49	91.51	209	115	0.857	11.15		Moist gas	
6.44	93.56	209	116	0.780	9.65			
5.66	94.34	209	118	0.733	9.00			

2O₃ → 3O₂.—(Continued)

Vol. % O ₃	Vol. % O ₂	λ	10 ⁻² E _T	A	n	N*	Remarks	Lit.
8.60	91.40	253	100	1.00	6.53		Moist gas	(48)
8.49	91.51	253	77	1.00	7.67			
7.80	92.20	253	104	1.00	6.24			
5.84	94.16	253	116	1.00	5.49			
5.43	94.57	253	144	1.00	4.75			
4.23	95.77	253	125	1.00	4.09			
3.54	96.46	253	136	1.00	3.87			
2.77	97.23	253	117	1.00	3.21			
0.91	99.09	253	124	1.00	2.05			
10.50	89.50	253	102	1.00	4.70		Moist gas	(48)
6.56	93.44	253	118	1.00	3.69			
4.47	95.53	253	106	0.99	3.17			
2.49	97.51	253	253	0.97	2.19			
2.23	97.77	253	96	0.97	3.08			
1.30	98.70	253	106	0.93	2.07			
0.80	99.20	253	83	0.86	1.66			
8.15	91.85	287	126	0.96	6.58		Moist gas	(48)
7.93	92.07	287	388	0.94	3.82			
6.27	93.73	287	433	0.93	2.90			
5.69	94.31	287	138	0.92	5.09			

H₂ + Cl₂ → 2HCl

λ	E _T	A	10 ⁻⁴ n	Remarks	Lit.
436	323-526	0.43-0.70	2.22-2.48	Gl, Sp, Ts	(27)

HBr → H + Br

P _{HBr} (mm Hg)	Mix. with	λ	10 ⁻² E _T	A	n	N*	Remarks	Lit.
20.3-30.3	H ₂	209	51-67	0.496-0.667	2.13±0.06	4	Fs, Sp, B.	(51)
120-156	H ₂	209	97-101	0.969-0.983	2.07±0.04	4	Streaming gas	
11.3-14.6	N ₂	209	30-46	0.289-0.383	2.03±0.10	4		
28.3-30.3	N ₂	209	46-66	0.635-0.676	2.10±0.03	3		
386-394	N ₂	209	101-104	0.985-0.987	1.96±0.01	2		
226-324	N ₂	209	75-109	0.946-0.981	1.92±0.12	3		
267-379	N ₂	209	37-51	0.495-0.608	1.99±0.09	7		

HI → H + I

P _{HI} (mm Hg)	Mix. with	λ	10 ⁻² E _T	A	n	N*	Remarks	Lit.
80.2-112.7	H ₂	207	124-152	0.967-0.997	1.95±0.03	7	Fs, Sp, B. Streaming	(52)
92.3-136	H ₂	253	144-189	0.929-0.982	2.06±0.04	6	gas	
260-344	H ₂	282	237-273	0.655-0.706	2.09±0.07	6		

NH₃ → N + 3H

p (mm Hg)	λ	10 ⁻² E _T	A	n	Remarks	Lit.
80-90	203-214	46-54	0.735-0.968	0.221±0.014	Fs, Sp, B	(46)
0.5-90	203-214			0.5-0.4	Fs, Sp, Ts. Differen-	(29)
	206.3			0.3-0.1	tial manometer	
3-30	203-214			0.4(θ = 20°)	Fs, Sp, Ts	(30)
				0.6(θ = 100°)		
				0.9(θ = 200°)		
				1.4(θ = 300°)		
				2.5(θ = 400°)		
				3.3(θ = 500°)		

Cl₂O → Cl₂ + O

λ	10 ⁻⁵ E _T	A	n	N*	Remarks	Lit.
blue-violet	1.38-3.89	0.25-0.60	2.26±0.04	11	Arc lamp, F, B, Ts, or air-thermometer	(12)
λ	10 ⁻² E _T	A	n	N*	Remarks	Lit.
430	18.7-34.2	0.40-0.67	1.995±0.005	2	Gl, F	(7)

2NOCl → 2NO + Cl₂

Arc lamp, F, Tp, Pressure measurement, A = ca. 0.90 (14)

λ	500-438 (470)	520-448 (485)
10 ⁻⁴ E _T	350	350
n.....	0.49	0.46
	0.47	0.52
	0.48	0.47

Acetic aldehyde → Acetone
(decomposition and polymerization)

λ	10 ⁻⁴ E _T	n	N*	Remarks	Lit.
UV(313).....	5.02	2.3		QQ. E measured with oxalic acid + U sulfate	(15)
UV(313).....	3.08-3.53	1.80±0.11	4		

* N indicates the number of experiments upon which the mean is based

Bromine + Hydrocarbons

Br ₂ +	λ	E _A	A	n	N*	Remarks	Lit.
C ₆ H ₁₂	530-440	1700	0.68-0.93	1.02±0.04	6	Gl, F, Ts.†	(38)
	476	336-532	0.595-0.938	1.08±0.03	5	Gl, F, Ts, Titr. of Br ₂	(40)
C ₆ H ₁₄	476	258-449	0.455-0.792	32			
C ₇ H ₁₆	476	162-502	0.285-0.885	8.4-19.6			
C ₆ H ₆ .CH ₃	476	162-438	0.285-0.772	7.1-57			

* N indicates the number of experiments upon which the mean is based.

† Spectrophotometric for Br₂.

SOLUTIONS

H₂O₂ → H₂O + O (in H₂O)

[H ₂ O ₂]	λ	E _A	α	A	n	Remarks	Lit.
0.037	214.4-298.0 (231)			0.025-0.92	114	Fs, Sp, Ts	(24)
0.023	210	1550	127	0.82	5.0	Fs, Sp, Ts	(25)
0.049	230	2823	75	0.88	4.9		
0.049	255.8	897	20	0.43	4.2		
0.049	280	538	3.0	0.082	3.7		

QQ, Uviol filter, Ts, α = 0.422, λ = 305 - 316 (311) (26)

[H ₂ O ₂]	[Z]	E _A	A	n	[H ₂ O ₂]	[Z]	E _A	A	n
0.525		85	0.492	75.0	0.316	1.0 × 10 ⁻⁵	187	0.335	69.8
0.525		249	0.492	78.9	0.317	0.5 × 10 ⁻⁴	205	0.335	60.6
0.389		205	0.395	68.8	1.032	0.5 × 10 ⁻³	338	0.736	40.8
0.319		227	0.338	59.3	0.463	0.5 × 10 ⁻³	262	0.449	33.4
0.276		196	0.298	54.0	0.283	0.5 × 10 ⁻³	170	0.305	36.5
0.126		105	0.151	45.8	0.170	0.5 × 10 ⁻³	107	0.196	31.4
0.053		49	0.067	45.3	0.0548	0.5 × 10 ⁻³	36	0.069	29.3
0.049		41	0.060	43.4	0.0293	0.5 × 10 ⁻³	21	0.034	24.5
0.016		26	0.020	23.2	0.541	0.5 × 10 ⁻²	252	0.503	21.3
0.311		140	0.330	74.2	0.362	0.5 × 10 ⁻²	190	0.373	25.9
0.303*	0.5 × 10 ⁻¹	140	0.324	74.2	0.255	0.5 × 10 ⁻²	130	0.280	26.0
0.305†	0.25 × 10 ⁻⁵	211	0.325	61.4	0.1046	0.5 × 10 ⁻²	59	0.127	26.6
0.572	0.5 × 10 ⁻⁵	352	0.521	57.4	0.0512	0.5 × 10 ⁻²	31	0.065	23.1
0.382	0.5 × 10 ⁻⁶	215	0.389	68.3	0.560	0.5 × 10 ⁻¹	390	0.515	14.1
0.327	0.5 × 10 ⁻⁶	215	0.344	63.0	0.388	0.5 × 10 ⁻¹	355	0.393	17.9
0.323	0.5 × 10 ⁻⁶	223	0.341	76.0	0.2487	0.5 × 10 ⁻¹	172	0.274	14.8
0.297	0.5 × 10 ⁻⁶	207	0.318	59.4	0.1332	0.5 × 10 ⁻¹	92	0.159	14.9
0.284	0.5 × 10 ⁻⁶	205	0.307	54.2	0.0415	0.5 × 10 ⁻¹	42	0.052	12.2
0.054	0.5 × 10 ⁻⁶	52	0.067	38.7	0.0280	0.5 × 10 ⁻¹	36	0.036	6.8

* Z is Na₂SO₄.† For this and all values which follow, Z is H₂SO₄.

Cl-Compounds

Substance	[Subs.]	10 ⁻⁵ E _T	A	n	N*	Remarks	Lit.
ClO ₂	0.317-0.0346	1.79-3.46	0.90-0.57	0.83±0.02	12	Soln. in CCl ₄ . Arc	(11)
Cl ₂ O	0.145-0.0855	1.61-2.31	0.60-0.42	0.90±0.03	7	lamp F (λ = 445),	
NCl ₃	0.43-0.227	1.08-1.65	0.43-0.28	0.85-3.7		B. ±25%	

HI → H + I (liquid)

λ	10 ⁻² E _T	A	n	N*	Remarks	Lit.
UV (300)	73.9-77.6	1.0	1.84±0.02	4	QQ, Ts, Spectrophotometric measurement.	(6)

* N indicates the number of experiments upon which the mean is based.

HI + O₂QQ, Sp, Ts; constant O₂-concn.; 17.1-23.2°C; A = 1 (63); cf. (39, 64)

$\lambda =$			436		405		313		280	
[KI]	[HCl]	10^3 [O ₂]	E_A	n	E_A	n	E_A	n	E_A	n
0.955	0.239	1.03	120	5.8	72	7.0	105	7.1	17	19.9
0.955	0.239	1.03	116	6.0	71	8.1	106	5.7	15	26.6
0.954	0.954	0.84	133	9.7	80	12.0	115	10.1	22	24.0
0.954	0.954	0.84	127	14.5	71	13.1	114	11.8	17	23.0
0.954	0.954	0.84	125	9.2	69	16.0			15	20.0
0.954	0.954	0.84	95	12.0						
0.954	0.954	0.84	95	12.8						
0.954	0.954	0.50							17	21.9
0.954	0.954	0.50							17	20.0
0.954	0.954	0.17	150	2.5	88	2.7	91	3.8	17	3.7
0.954	0.954	0.17	146	3.1	71	3.7	82	4.1	14	3.9
0.954	2.861	0.74	128	16.6	79	18.4	110	13.8	18	35.8
0.954	2.861	0.74	120	17.2	75	22.0	105	16.9	17	31.9
0.248	0.989	1.18	152	0.9	72	2.1	104	1.2	20	3.9
0.248	0.989	1.18	142	1.2	69	2.0	100	1.7	19	3.9
0.248	0.989	1.18	117	0.8			99	2.5		
0.248	0.989	1.18	114	1.2						
2.619	0.873	0.58	127	8.8	75	13.1	101	10.6	19	28.3
2.619	0.873	0.58	119	10.0	73	14.2	100	11.7	17	23.6
0.248	0.247	1.23	80	0.5	82	0.6	99	0.7	19	2.2
0.248	0.247	1.23	77	0.5	74	0.6	96	1.1	18	1.6

HI + O₂—(Continued)

$\lambda =$			436		405		313		280	
[KI]	[HCl]	$10^3 [\text{O}_2]$	E_A	n	E_A	n	E_A	n	E_A	n
0.248	0.247	1.23					93	10.6		
1.860	1.860	0.68	118	12.2	80	12.9	101	10.2	19	10.5
1.860	1.860	0.68	77	14.4	72	14.5	98		18	12.7
2.426	2.426	0.61							22	16.8
2.426	2.426	0.61							17	23.9
2.426	2.426	0.61							17	25.7
2.426	2.426	0.61							17	30.3

λ = 366

[KI]	[HCl]	10 ³ [O ₂]	E _A	n	[KI]	[HCl]	10 ³ [O ₂]	E _A	n
0.955	0.05	1.14	307	1.4	0.954	0.954	0.84	320	3.3
0.955	0.05	1.14	274	1.9	0.954	0.954	0.84	294	3.4
0.955	0.05	1.14	247	1.7	0.954	0.954	0.84	254	4.1
0.955	0.125	1.08	314	1.8	0.954	0.954	0.84	240	4.4
0.955	0.125	1.08	307	1.8	0.954	0.954	0.84	227	5.7
0.955	0.125	1.08	207	2.7	0.954	0.954	0.84	220	5.2
0.955	0.239	1.03	307	2.6	0.954	0.954	0.84	207	5.6
0.955	0.239	1.03	227	2.6	0.954	0.954	0.84	160	7.2
0.955	0.239	1.03	200	3.3	0.954	0.954	0.84	154	7.5
0.954	0.478	0.96	287	3.0	0.954	0.954	0.84	154	7.6
0.954	0.478	0.96	267	3.4	0.954	0.954	0.84	147	6.2
0.954	0.478	0.96	214	3.6	0.954	0.954	0.84	87	10.4
0.954	1.910	0.77	267	4.5	0.954	0.954	0.84	80	11.0
0.954	1.910	0.77	260	4.3	0.954	0.954	0.84	48	11.6
0.954	1.910	0.77	247	5.1	0.954	0.954	0.84	45	10.9
0.954	2.861	0.74	334	4.3	0.954	0.954	0.84	23	25.9
0.954	2.861	0.74	300	5.2	0.954	0.954	0.84	23	18.7
0.954	2.861	0.74	274	6.1	0.954	0.954	0.84	23	21.2
0.248	0.989	1.18	320	0.9	0.954	0.954	0.84	9.3	26.0
0.248	0.989	1.18	294	1.0	0.954	0.954	0.84	9.3	41.5
0.248	0.989	1.18	227	1.1	0.954	0.954	0.50	327	3.0
0.490	0.977	1.02	327	3.1	0.954	0.954	0.50	287	3.8
0.490	0.977	1.02	320	3.0	0.954	0.954	0.50	274	3.8
0.490	0.977	1.02	254	4.1	0.954	0.954	0.17	307	1.6
1.786	0.915	0.69	300	4.2	0.954	0.954	0.17	287	1.4
1.786	0.915	0.69	274	4.0	0.954	0.954	0.17	267	1.7
1.786	0.915	0.69	254	4.7	1.860	1.860	0.68	280	4.5
2.619	0.873	0.58	307	3.7	1.860	1.860	0.68	267	4.2
2.619	0.873	0.58	274	3.7	1.860	1.860	0.68	254	4.5
2.619	0.873	0.58	267	5.2	2.426	2.426	0.61	294	5.0
0.248	0.247	1.23	294	0.3	2.426	2.426	0.61	280	5.0
0.248	0.247	1.23	267	0.3	2.426	2.426	0.61	267	4.8
0.248	0.247	1.23	254	0.3	λ = 254				
0.487	0.487	1.06	307	1.8					
0.487	0.487	1.06	300	2.2					
0.487	0.487	1.06	260	2.5					
					0.954	0.954	0.84	39	12.0

Hydrolysis of PtCl₄(OH)₂H₂

QQ, Sp, Ts; conductivity measurements (7)

10 ⁴ [Pt]	λ	E _A	10 ⁻⁷ α	A	n
0.2	253.6	6.4	0.63	0.14	0.3
0.5	253.6	13.6	0.63	0.29	0.9
0.75	253.6	17.9	0.63	0.38	1.5
1	253.6	21.4	0.63	0.46	1.8
1.5	253.6	27.2	0.63	0.58	2.6
2	253.6	33.6	0.63	0.72	3.4
1	237.8	0.96	0.82	0.33	4.2
1	240.0	3.3	0.80	0.31	3.2
1	248.2	6.4	0.70	0.28	2.5
1	253.6	19.8	0.63	0.25	1.8
1	265.5	18.3	0.47	0.19	1.5
1	297.0	34.8	0.16	0.07	0.30
1	310.0	119	0.095	0.04	0.09
1	366.0	159	0.019	0.009	0.035
1	435.0	123	0.0052	0.003	0.008
1	546.0	129	0.0022	0.001	0.003

2Fe⁺⁺⁺ + 2I⁻ ⇌ 2Fe⁺⁺ + I₂ (displacement of equilibrium) (42)

QQ, F, Ts	λ	10 ⁻² E _T	A	n
	579	365	0.61	0.93

2K₃Co(C₂O₄)₃ = 2CoC₂O₄ + 3K₂C₂O₄ + 2CO₂ (aqueous solution)
QQ, F, Ts; extinction measurement (45)

λ =		436		405		366	
[K ₃ CoOx ₃]		E _A	A	n	E _A	A	n
0.005		12.3	0.47	0.53	13.0	0.83	0.82
0.002		6.0	0.23	0.43	8.0	0.51	0.71
0.001		3.1	0.12	0.71	4.7	0.30	1.00
0.0002		0.8	0.03	0.60	1.1	0.07	0.94

Cl₂ + 2CBrCl₃ = 2CCl₄ + Br₂ (dilution with CCl₄)

[CBrCl ₃]:[CCl ₄]	λ	10 ⁻² E _A	n	N*	Remarks	Lit
1:0	410-391 (410)	170	0.94 ± 0.03	15	Gl, F, Ts. Spectro-	(38)
1:0	468-440 (449)	156	0.90 ± 0.10	6	photometric for Br ₂ . A = 0.50-0.70	
1:4.07	blue and violet		0.98		Gl, F. Relative	(22)
1:9.15			0.94		energy measure-	
1:19.3			0.94		ment. Spectro-	
1:39.7				1.04	photometric for	
1:80.3				0.87	Br ₂	

Diluted with SiCl₄

CBrCl ₃ :SiCl ₄	n	CBrCl ₃ :SiCl ₄	n
1:0.889	0.90	1:64.3	0.77
1:2.48	0.87	1:162	0.67
1:7.24	0.96	1:324	0.57
1:16.33	0.94	1:647	0.39
1:32.3	0.98		

2CBrCl₃ + O₂ = 2COCl₂ + Br₂ + Cl₂ (22)Sensitized with Br₂, 880 g/l.λ = 436, 405; E_A = 454; A = 0.87

System	n	N*	Remarks
Pure CBrCl ₃ , satd. with O ₂	1.07		Uviol lamp, F, Ts, spec-
1 vol. CBrCl ₃ and 15 vols. CCl ₄ , satd. with O ₂	0.71 ± 0.05	4	trophotometric for Br ₂ ; ± 20 %
1 vol. CBrCl ₃ and 15 vols. CCl ₄ , satd. with air.....	0.88 ± 0.06	11	

Hydrolysis of monochloro- and monobromoacetic acids QQ, Sp, Ts. λ = 254. Electrometric titr. RG constant. n, ± 11 - 18% (43).

Substance	[Subs.]	E _A	λ	A	n
ClCH ₂ CO ₂ H.....	0.5	72	0.84	0.86	1.05
	0.3	61	0.94	0.72	0.95
BrCH ₂ CO ₂ H.....	0.02	66	22	0.87	0.35
	0.01	53	27.5	0.72	0.32
BrCH ₂ CO ₂ Na.....	0.02	51			0.47
(in 0.02N NaOH).....	0.02	48			0.54
(in 0.04N Na ₂ SO ₄).....	0.02	43			0.36

Organic acids + Br₂

Br ₂ +	λ	E _A	A	n	Remarks	Lit.
Lactic acid.....	530-490(500)	8.10 ²	0.70	0.22	Gl, F, Ts, or	(18)
Ca lactate.....	530-490(500)	8.10 ³	0.70	0.6-1.0	radio-mi-	(18)
Tartaric acid					crometer	
[Br ₂] = 0.015.....	490-450	360		ca. 12		(20)
[Br ₂] = 0.0325.....	490-450	360		ca. 4		(20)
Cinnamic acid (in CCl ₄).....	650-390(470)	32	0.17	436		(21)
Stilbene (in CCl ₄).....	650-390(470)	32	0.17	290		(21)

Oxidation with I₂ (37)

I ₂	λ	10 ³ E _T	A	n	Remarks
K formate.....	460-316(388)	11	0.218.3		Gl, radio-micrometer; θ = 31°C
K oxalate.....		11	0.191.2		
FeSO ₄		13.3	0.321.95		
NaNO ₂		9.3	0.160.7		

o-Nitrobenzaldehyde (in acetone) (58)

λ	E _A	A	n	N*	Remarks
436	10.4 - 80	0.035-0.245	0.469 ± 0.026	10	QQ, F, B, conductivity
405	600 - 820	0.606-0.975	0.473 ± 0.020	7	
366	810 - 1140	0.76 - 1.00	0.533 ± 0.015	14	

* N indicates the number of experiments upon which the mean is based.

λ	$10^5 E_T$	A	n	Remarks	Lit.
<i>o</i> -Nitrobenzaldehyde \rightarrow <i>o</i> -Nitrosobenzoic acid (in acetone)					
405	67	1	1.3	QQ, F, Sk, conduc-	(31, 60)
366	25	1	3.2	tivity	
Anthracene \rightarrow Dianthrane (in phenetole)					
400	23	1	0.49	QQ, glass filter	(28, 59); cf. (5)
β -Methylanthracene \rightarrow Dimethyldianthrane (in phenetole)					
400	23	1	0.39	QQ, glass filter	(28, 59); cf. (5)

Acetone + H₂O

System	λ	A	n	Remarks	Lit.
Acetone + H ₂ O (1 M)	298-214.4(231)	0.38-1.00	1175	Fs, Ts, Titr.	(24)

ϵ	λ	$10^4 E_T$	n	Remarks	Lit.
0.3	UV (313)	3.8	0.06	QQ. E measured with oxalic	(15)
15		7.2	0.15	acid + U sulfate.	

K oxalate + I₂; $\lambda = 486$, blue. $n = ca. 0.11$ (3)

λ	$10^5 E_T$	A	n	Remarks	Lit.
Oxalic acid + Uranyl nitrate (both 0.001M)					
253.6	37.1	0.80	47	QQ, Sp, Ts, $\alpha = 2.3 \times 10^6$	(8)

Oxalic acid (0.033M) + Uranyl sulfate (0.016M)

492.7-407.2(423)	10.6	0.72	1.07 \pm 0.02	Incand. lamp.	(16)
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* Spectrophotometric for the energy. Titr. $\pm 20\%$.

Oxalic acid + Uranyl sulfate (1)

λ	$10^{-2} EA$	n	Remarks
356	328	0.027	QQ. Titr. with KMnO ₄ .

λ	$10^{-5} E$	A	n	Remarks	Lit.
313	1.18	0.43	1.06 \pm 0.05	QQ, Ts.*	(15)

* Titr. with KMnO₄. [acid] = 0.1N. [sulfate] = 0.01M.

λ	A	n	λ	A	n
Fumaric acid \rightarrow Maleic acid (in H ₂ O) (53*)					
0.0102M			0.00306M		
207	1	0.104	207	1	0.080
253	1	0.098	253	0.95	0.087
282	0.857	0.134	282	0.553	0.099
Maleic acid \rightarrow Fumaric acid (in H ₂ O) (53*)					
0.0102M			0.00514M		
207	1	0.032	207	1	0.037
253	0.99	0.043	253	0.97	0.049
282	0.725	0.032	282	0.531	0.035

* Fs, Sp, B, stirring, conductivity.

Ethyl malate + Br₂ (in CCl₄)

QQ. Analysis by M. P. determination. RG proportional to E_A , independent of Br₂ (limits 1:9) and of CCl₄ (limits 1:5). 18°C. TK for the absorbed energy = 2 (17).

λ	557	436	366
n	429	565	684.5

Allocinnamylideneacetic acid (catalysed by I₂)

[Acid] (mol/l)	λ	$10^{-3} EA$	n	Remarks	Lit.
0.171	500	25	0.36	Gl, F	(19)
0.342	500	25	0.83		

CO₂-Assimilation

λ	$10^5 E_T$	A	n	Remarks	Lit.
610-690(600)	730-1570	1	0.226	QQ or Gl, Sp, or F, B.	(55)

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Anderson and Robinson, *1*, 47: 718; 25. (2) Berthelot and Gaudechon, *34*, 156: 707; 13. (3) Berthoud and Bellenot, *42*, 21: 308; 24. (4) Bodenstein, *7*, 85: 329; 13. (5) Bodenstein, *7*, 87: 93; 14. (6) Bodenstein and Lieneweg, *7*, 119: 123; 26. (7) Bodenstein and Kistiakowski, *7*, 116: 371; 25. (8) Boll, *Thesis*, Paris, 1914. *34*, 156: 691; 13. 157: 115; 13. (9) Bonhoeffer, *96*, 13: 94; 23.
- (10) Book and Eggert, *9*, 29: 521; 23. (11) Bowen, *4*, 123: 1199; 23. (12) Bowen, *4*, 123: 2328; 23. (13) Bowen, Hartley, Scott and Watts, *4*, 125: 1218; 24. (14) Bowen and Sharp, *4*, 127: 1026; 25. (15) Bowen and Watts, *4*, 1926: 1607. (16) Büchi, *7*, 111: 304; 24. (17) Eggert, *63*, 25: 19; 24. (18) Ghosh and Basu, *482*, 2: 39; 25. (19) Ghosh and Gupta, *482*, 2: 241; 25. (20) Ghosh and Mukherjee, *482*, 2: 165; 25. (21) Ghosh and Purkayastha, *482*,

- 2: 261; 25. (22) Grüss, *9*, 29: 144; 23. (23) Hatt, *7*, 92: 513; 18. (24) Henri and Wurmser, *34*, 156: 1012; 13. *51*, 3: 320; 13. (25) Henri and Wurmser, *34*, 157: 126; 13. (26) Kornfeld, *99*, 21: 66; 21. (27) Kornfeld and Müller, *7*, 117: 242; 25. 118: 476; 25. (28) Krüger, *Diss.*, Berlin, 1913. (29) Kuhn, *34*, 177: 956; 23.
- (30) Kuhn, *34*, 178: 708; 24. (31) Kummerer, *Diss.*, Berlin, 1914. (32) Laderburg, *63*, 5: 525; 04. (33) Lasareff, *8*, 24: 661; 07. (34) Lemoine, *6*, 6: 433; 95. (35) Lewis and Rideal, *4*, 1926: 596. (36) Luther and Forbes, *1*, 31: 770; 09. (37) Mukherjee and Dhar, *9*, 31: 621; 25. (38) Noddack, *9*, 27: 359; 21. (39) Plotnikow, *7*, 111: 171; 24.
- (40) Pusch, *9*, 24: 336; 18. (41) Rideal and Norrish, *5*, 103: 366; 23. (42) Rideal and Williams, *4*, 127: 258; 25. (43) Rudberg, *96*, 24: 247; 24. (44) Sebelien, *Norske Vid. Selsk. Skr. Math.-naturv. Kl.*, 1904: No. 9. (45) Vránek, *9*, 23: 336; 17. (46) Warburg, *76*, 1911: 746. (47) Warburg, *76*, 1912: 216. (48) Warburg, *76*, 1913: 644. (49) Warburg, *76*, 1914: 872.
- (50) Warburg, *76*, 1915: 230. (51) Warburg, *76*, 1916: 314. (52) Warburg, *76*, 1918: 300. (53) Warburg, *76*, 1919: 960. (54) Warburg, *9*, 27: 133; 21. (55) Warburg and Negelein, *7*, 106: 191; 23. (56) Weigert, *7*, 80: 78; 12. (57) Weigert, *Nernst Festschrift*, 464; 12. (58) Weigert and Brodmann, *83*, 21: 453; 26. *7*, 120: 24; 26. (59) Weigert and Krüger, *7*, 85: 579; 13. 86: 383; 14.
- (60) Weigert and Kummerer, *25*, 46: 1207, 1884; 13. (61) Wigand, *7*, 77: 423; 11. (62) Winther, *99*, 11: 92; 12. (63) Winther, *7*, 108: 236; 24. (64) Winther, *7*, 113: 275; 24. (65) Winther and Oxholt-Howe, *99*, 14: 196; 14.

GENERAL BIBLIOGRAPHY

(The numbers refer to the list of literature citations on p. 171)

- After effects: (96, 97, 129, 165).
Autocatalysis: (4, 71, 161, 165, 197).
Catalysis: (3, 4, 7.5, 18, 18.5, 30, 32.5, 37, 38, 38.5, 39, 42, 43, 44, 67.5, 75, 76, 77, 79, 86, 89, 90, 91, 93, 98, 125, 126, 128, 131, 131.1, 131.2, 131.5, 137, 145, 156, 162, 164, 169, 180, 181, 193).
Color sensitivity: (3, 36, 49, 57, 83, 84, 87, 103, 105, 108.5, 110, 120, 136, 140, 176, 187, 189, 193, 197, 199, 201).
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Monomolecular: (2, 17, 23, 26, 28, 32, 34, 40, 46, 55, 64, 80, 82, 95, 96, 97, 113, 125, 134, 135, 139, 143, 146, 148, 149, 152, 163, 168, 169, 200).
Bimolecular: (15, 24, 29, 75, 94, 134, 135, 174).
Velocity and intensity: (8, 20.5, 24, 24.5, 32.5, 34, 35, 48, 64, 72, 73, 82, 103, 108, 111, 123, 134, 141, 153, 154, 157, 169, 181, 189).
Retardation by oxygen: (24, 42, 43, 46, 74, 78, 121, 150, 185).
Systems:
Ammonia: (58).
Bromates: (151).
Bromine + organic compounds: (3, 10, 20, 20.5, 33, 40, 141, 150, 164).
Carbon monoxide + halogens: (39, 42, 138, 167, 171, 179, 192).
Carbon monoxide + oxygen: (41, 60, 171).
Carbonyl chloride (phosgene): (54, 179).
Chlorates: (151, 162.5).
Chlorine + organic compounds: (12, 74, 142, 142.5, 156).
Chlorine + water: (0.5, 16, 17, 22, 98, 131, 200).
Chromium trioxide + organic compounds: (69, 73, 120).
Cobalt compounds: (18.5, 36, 86).
Copper salts: (167).
Dyes: (108.5, 136.5).
Eder's solution: (18, 89, 90, 136, 150, 152, 193, 198).
Enzymes: (49, 50).
Fehling's solution: (14, 27, 110).
Ferric salts + iodine: (149.5, 153).
Ferric salts + organic compounds: (9, 10, 11, 13, 16, 88, 111, 136, 143, 151, 194, 199).
Ferrous sulfate: (167).
Halogen acids: (23, 31, 59, 63, 72, 136, 137, 139, 161, 171, 197).
Hydrogen: (38.5).
Hydrogen + halogens: (8, 21, 24, 24.5, 35, 37, 43, 44, 45, 46, 47, 48, 56, 57, 62, 70, 117, 124, 131.3, 171, 188).
Hydrogen + oxygen: (2, 7.5, 55, 61, 67.5, 131.2, 171).
Hydrogen peroxide: (82, 93, 125, 163, 168, 169).
Hydrogen peroxide + organic compounds: (81, 94, 96, 97, 196).
Iodic acid + oxalic acid: (112).
Iodine + organic compounds: (20, 20.5, 32.5, 67).

LITERATURE

(For a key to the periodicals see end of volume)

Abbreviations:

QQ Quartz mercury vapor lamp.	λ Wave length in μμ.
Sp. Spectral purification of monochromatic radiation.	I Intensity.
F Light filter (wave filter).	RV Reaction velocity.
UV Ultra-violet radiation.	C Concentration.
	t Temperature, °C
	TC Temperature coefficient.

(0.⁵) Allmand, Cunliffe and Maddison, *4*, **127**: 822; 25. ($\text{Cl}_2 + \text{H}_2\text{O}$. QQ. Stationary state.) (1.⁵) Anderson and Robinson, *1*, **47**: 718; 25. (Oxalic acid + uranyl sulfate. QQ. Constant velocity. Absolute actinometer. TC.) (2) Andrejeff, *53*, **43**: 1342; 11. *9*, **19**: 551; 13. ($2\text{H}_2\text{O} \rightleftharpoons 2\text{H}_2 + \text{O}_2$. QQ. [amalgam]. UV. $t = 260\text{--}290$. $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$. RV. Monomolecular. $t = 113$.) (3) Andrich and Le Blanc, *99*, **15**: 148, 183, 197; 16. ($\text{Br}_2 + \text{toluene}$. Arc lamp. F. Extinction. Color sensitivity. Action of O_2 and other substances.) (4) Archibald, *4*, **117**: 1104; 20. (Hydrolysis of K_2PtCl_6 . Incandescent lamp. Analysis [titration of HCl]. Autocatalysis. Stationary state.) (5) Archibald and Gale, *4*, **121**: 2849; 22. (Hydrolysis of K_2PtBr_6 . Incandescent lamp. Analysis [titration of HBr].) (6) Bacon, *267*, **5 A**: 281; 10. (Oxalic acid + uranyl acetate.) (7) Bahr, *8*, **33**: 598; 10. ($2\text{O}_3 \rightarrow 3\text{O}_2$. UV. RV at various pressures.) (7.⁵) Baker and Carlton, *4*, **127**: 1990; 25. ($\text{H}_2 + \text{O}_2$. Effect of water.) (8) Baly and Barker, *4*, **119**: 653; 21. ($\text{H}_2 + \text{Cl}_2$. No proportionality between RV and I .) (9) Benrath, *52*, **80**: 283; 09. ($\text{FeCl}_3 + \text{alcohol}$. UV. Decolorizing time proportional to FeCl_3 concentration.)

(10) Benrath, *7*, **74**: 115; 10. ($\text{FeCl}_3 + \text{organic acids or glycerol}$. $\text{Br}_2 + \text{tartaric acid}$. UV. Measurement of decolorizing time.) (11) Benrath, *13*, **382**: 222; 11. ($\text{FeCl}_3 + \text{alcohol}$, $\text{CHCl}_3 + \text{aqueous alcohol}$, methyl acetate, chloroacetic acid. UV. RV.) (12) Benrath and Hertel, *99*, **23**: 30; 24. (Chlorination of chloroform, acetic anhydride, acetic acid, acetyl chloride, isobutyric acid, propionic acid, *n*-butyric acid, dimethyl malonate, ethyl ether. QQ. Empirical equation for RV.) (13) Benrath, Hess and Obladen, *99*, **22**: 47; 22. ($\text{FeCl}_3 + \text{organic acids}$. Oxalic acid + uranyl acetate + electrolytes. Daylight. Acid concentration has no effect.) (14) Benrath and Oberbach, *7*, **98**: 498; 21. (Fehling's solution. Sunlight, UV.) (15) Benrath and Obladen, *99*, **22**: 65; 22. ($\text{TiCl}_4 + \text{mandelic acid}$. Daylight or QQ. Change of C . Bimolecular.) (16) Benrath and Schafiganz, *7*, **103**: 139; 22. ($\text{FeCl}_3 + \text{tartaric acid} + \text{silicic acid jellies}$. $\text{Cl}_2 + \text{H}_2\text{O} + \text{silicic acid jellies}$. Spatial progress of reaction.) (17) Benrath and Tüchel, *99*, **13**: 383; 14. **14**: 238; 15. Criticism by Dawson, *99*, **14**: 213; 14. ($\text{Cl}_2 + \text{H}_2\text{O}$. QQ. Monomolecular.) (18) Berger, *70*, **40**: 387; 21. (Eder's solution + electrolytes.) (18.⁵) Berger, *70*, **44**: 47; 25. (Uranyl formate + formic acid, complex cobalt salts. QQ. Stirring. Salt effect. Curves for time and RV.) (19) Berthelot and Gaudechon, *34*, **156**: 707; 13. (Levulose. UV. Decomposition at various C .)

(20) Berthoud and Bellenot, *37*, **7**: 307; 24. ($\text{K oxalate} + \text{Br}_2$ or I_2 . Incandescent lamp, F. No stirring. RV proportional to \sqrt{I} . Kinetics. TC.) (20.⁵) Berthoud and Bellenot, *42*, **21**: 308; 24. ($\text{K oxalate} + \text{I}_2$. Incandescent lamp, F. Equation given for RV for red [weak absorption] and for blue [strong absorption]. TC. $\text{K oxalate} + \text{Br}_2$.) (21) Bevan, *5*, **202**: 71; 04. ($\text{H}_2 + \text{Cl}_2$. Kinetics.) (22) Billitzer, *Jahrbuch für Photographie und Reproduktionstechnik*, **1907**: 82. ($\text{Cl}_2 + \text{H}_2\text{O}$. Kinetics.) (23) Bodenstein, *7*, **22**: 23; 97. **61**: 417; 08. ($\text{HI} \rightarrow \text{H}_2 + \text{I}_2$. Daylight. Monomolecular.) (24) Bodenstein and Dux, *7*, **85**: 297; 13. ($\text{H}_2 + \text{Cl}_2$. Incandescent lamp. No stirring. Equation given for RV.) (24.⁵) Bodenstein and Lütkemeyer, *7*, **114**: 208; 24. ($\text{H}_2 + \text{Br}_2$. Tungsten arc lamp. $t = 218$. TC. Equa-

tion for RV.) (25) Bohm, *Diss.*, Berlin, 1913. ($\text{O}_3 + \text{H}_2$. QQ. Variation of C . Kinetics. TC.) (26) Bolin, 7, 87: 490; 14. (Lactic acid + uranyl sulfate. Arc lamp, glass filter. Without O_2 , monomolecular. With O_2 , constant velocity.) (27) Bolin and Linder, 7, 93: 721; 19. (Fehling's solution. UV. Kinetics.) (28) Boll, *Thesis*, Paris, 1914. 34, 156: 138, 691, 1891; 13. 157: 115; 13. (Oxalic acid + uranyl nitrate. QQ. $\lambda = 253.6$. Analysis [conductivity measurements]. Monomolecular.) (29) Boll and Job, 34, 15: 883; 12. See also Job and Boll, 34, 155: 827; 12. (Hydrolysis of H_2PtCl_6 . QQ. Analysis [conductivity measurements]. Bimolecular.) (30) Bose, 58, 112: 95; 23. (CO_2 assimilation. Catalysis by very small amounts of material.) (31) Bowen, 4, 125: 1233; 24. (Mathematical treatment of the formation and decomposition of halogen acids.) (31.5) Bowen and Sharp, 4, 127: 1026; 25. ($2\text{NOCl} = 2\text{NO} + \text{Cl}_2$. Arc lamp, F. Ts. $\lambda = 500 - 438$. Constant velocity. Recalculation of data of Kiss (95).) (32) Bredig and Goldberger, 7, 110: 521; 24. (Decomposition of formaldehyde. QQ. $t = 80$ and 195. Monomolecular at low C , constant velocity at high C [total absorption].) (32.5) Briers, Chapman and Walters, 4, 1926: 562. (K oxalate + I_2 . RV and I . Duration of catalytic effect.) (33) Bruner and Czarnecki, 165, 1910 A: 516. ($\text{Br}_2 + \text{toluene}$. Nernst lamp, violet lamp. Addition of I_2 makes reaction independent of O_2 . Constant velocity.) (34) Bruner and Krolkowski, 165, 1910 A: 192. (Maleic acid [$+\text{Br}_2$] \rightarrow fumaric acid. Sunlight. Monomolecular. TC ca. 1. Constant transformation coefficient for given intensity and bromine concentration.) (35) Bunsen and Roscoe, 8, 100: 43; 57. ($\text{H}_2 + \text{Cl}_2$. Constant velocity. RV proportional to I .) (36) Burger, 182, 27: 160; 11. (Pentamminenitrosocobalt salts. Sunlight. RV, color sensitivity.) (37) Burgess and Chapman, 4, 89: 1399; 06. ($\text{H}_2 + \text{Cl}_2$. Catalysts.) (38) Butler, 135, 125: 38; 22. ($\text{C}_2\text{H}_2 + \text{O}_2$. Incandescent lamp. Various solvents. Kinetics.) (38.5) Cario and Franck, 96, 11: 161; 22. ($\text{H}_2 \rightarrow 2\text{H}$. Sensitization with Hg . $\lambda = 253.67$.) (39) Cathala, 27, 33: 576; 23. ($\text{CO} + \text{Cl}_2$. QQ. Retardation with CO_2 .) (40) Cernovodeanu and Henri, 34, 149: 365; 09. (Tetanus toxin. QQ. RV proportional to C .) (41) Chapman, Chadwick and Ramsbottom, 4, 91: 942; 07. Criticism by Coehn, 200, 7: 613; 10. ($\text{CO}_2 = \text{CO} + \text{O}$. QQ.) (42) Chapman and Gee, 4, 99: 1726; 11. ($\text{CO} + \text{Cl}_2$. Retardation with O_2 , NO . TC.) (43) Chapman and MacMahon, 4, 95: 959; 09. ($\text{H}_2 + \text{Cl}_2$. Hefner lamp. Pressure measurement. Ratio for RV.) (44) Chapman and MacMahon, 4, 95: 1717; 09. 97: 845; 10. ($\text{H}_2 + \text{Cl}_2$. Catalysts.) (45) Chapman and Underhill, 4, 103: 491; 13. ($\text{H}_2 + \text{Cl}_2$. Change of H_2 pressure.) (46) Chapman and Whiston, 4, 115: 1264; 19. ($\text{H}_2 + \text{Cl}_2$. Change of Cl_2 pressure. Ratio for RV.) (47) Chapman, 4, 123: 3062; 23. Calculations by Berthoud, 37, 7: 324; 24. ($\text{H}_2 + \text{Cl}_2$. Change of H_2 , Cl_2 and O_2 pressure.) (48) Chapman, 4, 125: 1521; 24. ($\text{H}_2 + \text{Cl}_2$. Approximate proportionality between RV and I . [Variation 1: 6].) (49) Chauchard and Chauchard, 34, 156: 1858; 13. (Amylase. Color sensitivity in UV.) (50) Chauchard and Mazoué, 34, 152: 1709; 11. (Amylase, invertase. Decomposition velocity in UV.) (51) Clark and Allardyce, 69, 17 III: 167; 23. (Oxime formation. Visible and UV radiation.) (52) Coehn, 25, 43: 880; 10. ($2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$. QQ.) (53) Coehn and Becker, 7, 70: 88; 09. See also Becker, *Diss.*, Göttingen, 1908. ($\text{SO}_3 \rightleftharpoons \text{SO}_2 + \text{O}$. QQ. Equilibrium independent of t between 50 and 800° .) (54) Coehn and Becker, 25, 43: 130; 10. ($\text{COCl}_2 \rightarrow \text{CO} + \text{Cl}_2$. QQ.) (55) Coehn and Grote, *Nernst Festschrift*, 136; 13. See also Grote, *Diss.*, Göttingen, 1912. Criticism by Weigert, 25, 46: 815; 13. ($2\text{H}_2 + \text{O} \rightarrow 2\text{H}_2\text{O}$. QQ. Gases in motion. Monomolecular.) (56) Coehn and Jung, 25, 56: 696; 23. ($\text{H}_2 + \text{Cl}_2$. Very dry gases. UV.) (57) Coehn and Jung, 7, 110: 705; 24. ($\text{H} + \text{Cl}_2$. Incandescent lamp. Insensitive at a vapor pressure of $< 10^{-7}$ mm Hg. Sensitivity limit at $\lambda = 540$.) (58) Coehn and Prigent, 9, 20: 275; 14. ($2\text{NH}_3 \rightarrow \text{N}_2 + 3\text{H}_2$. QQ. Constant velocity.) (59) Coehn and Stuckardt, 188, 1916: 99. ($2\text{HBr} \rightarrow \text{H}_2 + \text{Br}_2$, $2\text{HI} \rightleftharpoons \text{H}_2 + \text{I}_2$. QQ. Unstirred gases. Equilibrium displacement and RV.) (60) Coehn and Tramm, 25, 54: 1148; 21. ($\text{CO} + \text{O}_2$. QQ. H_2O unimportant.) (61) Coehn and Tramm, 25, 56: 455; 23. ($\text{H}_2 + \text{O}_2$. QQ. H_2O unimportant.) (62) Coehn and Tramm, 25, 56: 458; 23. ($\text{H}_2 + \text{Cl}_2$. Visible light. Very dry gases. Insensitive.) (63) Coehn and Wassiljewa, 25, 42: 3183; 09. ($2\text{HCl} \rightarrow \text{H}_2 + \text{Cl}_2$. QQ.) (64) Cohen, 70, 39: 243; 20. (Benzophenone + alcohol. Sunlight. QQ. Ratio given for RV.) (65) Cohen, 64V, 32: 555; 23. 64P, 26: 443; 23. (Alcohol + O_2 .) (66) Dhar, 4, 111: 707; 17. (TC for different reactions. Daylight. RV in dark.) (67) Dhar, 14, 11: 130; 19. (K oxalate + I_2 . TC for reactions in light and dark.) (67.5) Dickinson, 197, 10: 409; 24. ($\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$. Sensitization with Hg . QQ.) (68) Euler and Ryd, 205, 51: 97; 13. (Lactic acid + $\text{H}_2\text{O} = \text{CO}_2 + \text{C}_2\text{H}_5\text{OH}$. UV. Induction period. TC.) (69) Forbes, Woodhouse and Dean, 1, 45: 1891; 23. (Quinine + $\text{CrO}_3 + \text{H}_2\text{SO}_4$. UV. Change in C .) (70) Gautier and Helier, 34, 124: 1128; 97. Calculations by Bevan, 5, 202: 71; 03. ($\text{H}_2 + \text{Cl}_2$.) (71) Genthe, *Diss.*, Leipzig, 1906. (Linseed oil + O_2 . Violet lamp. Autocatalysis.) (72) Gil, 132, 12: 534; 14. ($\text{HI} + \text{O}_2$. QQ or arc lamp. Confirmation of law $[I] \times [\text{time}] = \text{constant}$.) (73) Goldberg, 7, 41: 1; 02. 99, 4: 95; 06. (Quinine + CrO_3 . Sunlight, Violet lamp, Kinetics. TC. RV proportional to I .) (74) Goldberg, 99, 4: 61; 06. ($\text{Cl}_2 + \text{C}_6\text{H}_6$. Arc lamp. O_2 retardation.) (75) Griffith and Shutt, 4,

- 123: 2752; 23. ($2O_3 \rightarrow 3O_2$. Incandescent lamp. In mixtures with O_2 , RV proportional to $[O_3]^2$. Accelerated by H_2 .) (76) Griffith and Mac-Willie, 4, 123: 2767; 23. ($2O_3 \rightarrow 3O_2$. Incandescent lamp. Accelerated by He , A , N_2 , CO , CO_2 .) (77) Gros, 7, 37: 157; 01. (Leuco compounds + O_2 . Light sensitivity of fluoresceins and derivatives.) (78) Halban and Geigel, 7, 96: 233; 20. (Coloration and decoloration of tetra benzoyl ethylene. Sunlight, Uviol lamp. O_2 retardation.) (78.5) Hartung, 4, 125: 2198; 24. (AgBr. Sunlight. RV.) (79) Hatt, 7, 92: 513; 18. (Uranyl formate. Sunlight, incandescent lamp, QQ. Retardation by uranous salts. Kinetics. Added substances.)
- (80) Hecht, 223, 3: 1; 20. (Bleaching of visual purple [solution]. Incandescent lamp. Monomolecular.) (81) Henri and Ranc, 34, 154: 1261; 12. (Glycerol + H_2O_2 . UV.) (82) Henri and Wurmsier, 34, 157: 126; 13. ($H_2O_2 \rightarrow H_2O + O$. $\lambda = 280 - 210$. Monomolecular. RV proportional to the absorbed energy.) (83) Hill, 83, 20: 109; 24. ($3SO_2 = 2SO_3 + S$. Uviol lamp. Unilateral F. Sensitive to 313μ .) (84) Holmes, 1, 44: 1002; 22. (Triphenylmethanesulfonic acid. Equilibrium between the colored and colorless forms. Change with λ .) (85) Holmes, 483, 13: 188, 197; 24. (Oxalic acid and uranyl salts as chemical photometer in actinometer.) (86) Jaeger and Berger, 64P, 23: 84; 21. 70, 40: 153; 21. (K cobaltioxalate. QQ. RV independent of C . Salt effect.) (87) Job and Emschwiller, 34, 179: 52; 24. (Ethyl iodide. Sensitivity limit at 410μ .) (88) Jodin, 6, 27: 426; 82. (Ferric oxalate. Daylight.) (89) Jodlbauer and Tappeiner, 25, 38: 2602; 05. (Eder's solution. Dyestuffs as catalysts.)
- (90) Jodlbauer and Tappeiner, 484, 82: 520; 05. (KI + O_2 , Eder's solution, $As_2O_3 + O_2$. Catalysts.) (91) Jorissen and Reicher, 7, 31: 142; 99. (Oxalic acid + O_2 + various metallic salts. Daylight, sunlight. Effect of C of catalyst.) (92) Kailan, 57, 33: 1305; 12. 25, 46: 1628; 13. (*o*-Nitrobenzaldehyde \rightarrow *o*-nitrosobenzoic acid.) (93) Kailan, 7, 98: 495; 21. (H_2O_2 . QQ. Effect of H_2SO_4 .) (94) Kastle and Loevenhart, 1, 21: 262; 99. (H_2O_2 + formaldehyde. Sunlight. Bimolecular. TC.) (95) Kiss, 70, 42: 665; 23. ($NOCl \rightarrow NO + Cl$. Incandescent lamp. Monomolecular. TC.) (96) Kistiakowsky, 7, 35: 431; 00. ($H_2O_2 + K_3Fe(CN)_6 + K_3Fe(CN)_6$. Arc lamp. Partially monomolecular. After effect.) (97) Kistiakowsky, 169, 23: 1915. 10, 4: 924; 22. ($H_2O_2 + K_3Fe(CN)_6 + K_3Fe(CN)_6$. Monomolecular. After effect.) (98) Klimenko, 25, 28: 2558; 95. ($Cl_2 + H_2O$. Catalysts.) (99) Landau, 34, 152: 1308; 11. (Lactic acid. UV.)
- (100) Landau, 34, 155: 403; 12. (Polymerization of C_2H_4 . QQ.) (101) Landau, 34, 156: 1894; 13. (Oxalic acid + uranyl salts. UV.) (102) Langmuir, 1, 42: 2190; 20. (Radiation hypothesis and chemical action.) (103) Lasareff, 8, 24: 661; 07. (Fading of dyestuffs. Nernst lamp. Sp. Rotating sector. Sensitivity to various λ proportional to absorbed energy.) (104) Lasareff, 8, 37: 812; 12. (Fading of dyestuffs. Nernst lamp. Sp. Several absorption bands.) (105) Lasareff, 7, 78: 661; 12. 79: 638; 12. (Methylene blue. Nernst lamp. Sp. Color sensitivity.) (106) Lasareff, 134, 1919: 239. (Kinetics. Theory.) (107) Lasareff, 7, 98: 94; 21. (Fading of dyestuffs. High O_2 pressure. Relation between RV and O_2 pressure.) (108) Lasareff and Perrin, 34, 177: 1436; 23. (RV for periodically fluctuating I .) (108.5) Lasareff, 83, 21: 475; 26. 7, 120: 58; 26. (RV and λ . Fading of dyestuffs.) (109) Le Blanc, Andrich and Kangro, 9, 25: 229; 19. ($SO_2Cl_2 \rightleftharpoons SO_2 + Cl_2$. Spark gap, QQ, Sp, F. Extinction measurements. Equilibrium.)
- (110) Leighton, 50, 17: 205; 13. (Fehling's solution + hydroquinone. Color sensitivity.) (111) Lemoine, 6, 6: 433; 95. ($FeCl_3$ + oxalic acid. Sunlight. Relation between RV and absorption. TC. RV proportional to I .) (112) Lemoine, 34, 173: 192; 21. (Oxalic acid + HIO_3 . Sunlight. Kinetics.) (113) Lewis, 4, 101: 2371; 12. ($NaOCl \rightarrow NaCl + O$. Uviol lamp. $t = 25$. Stirring. Monomolecular in neutral and alkaline solution.) (114) Lewis and MacKeown, 1, 43: 1288; 21. (Radiation theory of thermal reactions.) (115) Lifschitz and Joffé, 25, 52: 1919; 19. (Di- and triphenylmethane derivatives in solution. UV. Reversible transformations.) (116) Lifschitz and Joffé, 7, 97: 426; 21. (Triarylmethane derivatives. UV. Equilibrium between colorless and colored forms.) (117) Lind, 50, 28: 55; 24. ($H_2 + Br_2$. Arc lamp. $t = 250$.) (118) Lombard, 27, 7: 186; 10. (KNO_3 . QQ. Kinetics.) (119) Luther, 7, 30: 628; 99. (AgCl. Daylight. Stationary state.)
- (120) Luther and Forbes, 1, 31: 770; 09. (Quinine + CrO_3 . Uviol lamp, F. Kinetics. Spectral effect additive. Color sensitivity.) (121) Luther and Goldberg, 7, 56: 43; 06. (O_2 retardation in Cl_2 reactions.) (122) Luther and Plotnikow, 7, 61: 513; 08. (Pseudoreversible reactions. $HI + H_3PO_3 + O_2$.) (123) Luther and Weigert, 7, 51: 297; 05. 53: 385; 05. (Anthracene \rightarrow dianthracene. Arc lamp. RV and stationary state. TC. RV proportional to I .) (124) Marshall and Taylor, 58, 112: 937; 23. ($H_2 + Cl_2$. Reaction mechanics.) (125) Mathews and Curtis, 50, 18: 166; 14. (H_2O_2 . Uviol lamp. Monomolecular. Negative catalysts. TC.) (126) Mathews and Curtis, 50, 18: 641; 14. (KIO_3 . QQ. Catalysis.) (127) Mathews and Dewey, 50, 17: 211; 13. (Oxalic acid + uranyl salts. QQ.) (128) Mathews and Weeks, 1, 39: 635; 17. ($Na_2SO_3 + O_2$. QQ. Negative catalysts.) (129) Mathews and Williamson, 1, 45: 2574; 23. (Acetylchloroaminobenzene. UV. Kinetics. After effects in nonaqueous solvents.)
- (130) Matuschek, 136, 25: 411, 522; 01. ($K_3Fe(CN)_6$. Daylight.) (131) Milbauer, 7, 86: 564; 14. ($Cl_2 + H_2O$. Catalysts.) (131.1) Moore and Noyes, 1, 46: 1367; 24. ($3O_2 \rightarrow 2O_3$. Sensitization with Hg .) (131.2) Norrish and Rideal, 4, 127: 787; 25. ($H_2 + O_2$. Sensitization with Cl_2 . QQ. Glass filter. RV proportional to $[O_2] \times [Cl_2]$.) (131.3) Norrish, 4, 127: 2317; 25. ($HI_2 + Cl_2$. Induction period.) (131.5) Noyes, 1, 47: 1003; 25. ($N_2 + 3H_2 \rightarrow 2NH_3$. Sensitization with Hg . QQ, F. $\lambda > 215\mu$.) (132) Noyes and Kouperman, 1, 45: 1398; 23. (Solid oxalic acid. UV. Induction period. Constant velocity.) (132.5) Padoa, 36, 55: 87; 25. (TC and λ .) (132.6) Padoa, 83, 21: 573; 26. 7, 120: 202; 26. (Spectral effect not additive.) (133) Padoa and Foresti, 22, 22 II: 576; 13. 36, 45 I: 21; 15. (Phototropy. Sunlight. Equilibrium at various temperatures.) (134) Padoa and Minganti, 22, 22 II: 500; 13. 36, 45 I: 15; 15. (Phototropy. Coloration monomolecular, decoloration in dark bimolecular. RV proportional to I . TC.) (135) Padoa and Zazzaroni, 22, 24 I: 828; 15. (Phototropy. Coloration bimolecular, decoloration monomolecular.) (136) Padoa and Vita, 36, 54: 147; 24. ($HI + O_2$, ferric oxalate, Eder's solution. Arc lamp, F. Spectral effect not additive.) (136.5) Perrin and Choucrour, 34, 178: 1401; 24. (Methylene blue, eosin in glycerol. RV and C .) (137) Pinnow, 25, 34: 2528; 01. 42, 63: 239; 01. ($HI + O_2$. Quinine as catalyst.) (138) Piva, 36, 45 I: 219; 15. ($CO + Br_2$. Sunlight.) (139) Plotnikow, 7, 58: 214; 07. 64: 215; 08. ($HI + O_2$. Uviol lamp. RV proportional to concentration of O_2 . Criticism by Winther, 137, 2: No. 2; 20.)
- (140) Plotnikow, 7, 78: 573; 12. 79: 641; 12. 9, 19: 753; 13. (Br_2 + benzene, cinnamic acid. Uviol lamp. Color sensitivity. Criticism by Bruner, 9, 19: 555; 13.) (141) Plotnikow, 99, 19: 1; 19. (Br_2 + α -phenylcinnamic nitrile. Uviol lamp. Equilibrium. Reaction order. Change in I .) (142) Plotnikow, 99, 19: 22; 19. ($Cl_2 + CCl_4$. Uviol lamp. Periodic reaction. Criticism by Grüss, 9, 29: 144; 23, and Benrath and Hertel, 99, 23: 30; 24.) (142.5) Plotnikow, 99, 23: 79; 24. (Aliphatic compounds + Cl_2 ; cf. Benrath and Hertel (12).) (143) Puxeddu and Vodret, 36, 52 I: 229; 22. ($FeCl_3$ + ethyl ether. Sunlight, arc lamp. Approximately monomolecular.) (144) Rankin, 50, 11: 1; 07. ($S_L \rightleftharpoons S_M$.) (145) Reddelien, Diss., Leipzig, 1908. (Phototropy. Kinetics. Catalysis.) (146) Regener, 8, 20: 1033; 06. Diss., Berlin, 1905. ($2O_3 \rightarrow 3O_2$. UV. Monomolecular.) (147) Reynolds and Taylor, 4, 101: 131; 12. (HNO_3 vapor. Sunlight. Reversible decomposition.) (148) Richardson, 4, 65: 450; 94. (Oxalic acid + O_2 . Daylight. Approximately monomolecular.) (149) Rideal and Norrish, 5, 103: 342; 23. ($KMnO_4$. UV. Pseudoreversible reaction. Monomolecular in neutral solution, constant velocity in acid solution. TC ca. 1.) (149.5) Rideal and Williams, 4, 127: 258; 25. ($Fe^{+++} + I^- \rightleftharpoons Fe^{++} + I$. Displacement of equilibrium. Incandescent lamp, QQ, F. Sensitive to $\lambda = 550-650$ and UV. I_2 is active. Effect of KCl. TC.)
- (150) Roloff, 7, 13: 327; 94. (Eder's solution. O_2 retardation. Oxalic acid + Br_2 .) (151) Ross, 1, 28: 786; 06. (KI. UV. Chlorates, bromates, organic Fe compounds. Constant velocity. Calculations by Kailan, 57, 34: 1209; 13.) (152) Sanyal and Dhar, 93, 128: 212; 23. (Eder's solution. Sunlight. RV proportional to concentration of oxalate, independent of $HgCl_2$.) (153) Sasaki, 429, 5: 315; 22. 93, 122: 61; 22. ($Fe^{+++} + I^- = Fe^{++} + I$. Incandescent lamp. Increasing I reverses the reaction.) (154) Schall, 99, 10: 89; 12. (*p*-Phenylenediamine nitrate paper. Only sensitive to UV. Measurement of action of UV.) (155) Schlenk and Herzenstein, 25, 43: 3541; 10. (Formation and decomposition of diphenylbiphenylmethyl. Sunlight. Reversible.) (156) Slatore, 7, 45: 513; 03. ($Cl_2 + C_6H_6$. Sunlight. Kinetics. Catalysis.) (157) Stobbe, 13, 359: 1; 08. (Triphenylfulgide. Phototropic transition. Discussion of effect of λ , t , and I .) (158) Stobbe and Schmidt, 99, 20: 57; 20. (Alkyl iodide + O_2 . QQ. Time curves.) (159) Stoermer, 25, 42: 4865; 09. (Transformation of stereoisomers.)
- (160) Stoermer and Heymann, 25, 46: 1249; 13. (Transformation of halogen cinnamic acids in UV. Curves for RV.) (161) Strachoff, 53, 48: 824; 16. 99, 18: 227; 19. 10, 4: 925; 22. ($HI + O_2$. Autocatalysis.) (162) Straub, 486, 51: 1093; 04. 277, 51: 383; 04. ($KI + O_2$ + catalysts. False equilibrium.) (162.5) Suryanarayana, 194, 2: 12; 24. (KI , no reaction to UV. KNO_3 , $KClO_3$, reversible reaction, UV.) (163) Swensson, 19, 7: No. 25; 20. (H_2O_2 . UV. Monomolecular. No after effects.) (164) Swensson, 99, 20: 206; 21. (Br_2 + aromatic hydrocarbons. Uviol lamp. Kinetics. Added substances.) (165) Szilard, 99, 4: 127; 06. (CHI_3 in $CHCl_3$. Autocatalysis. After effect. Course of the reaction.) (166) Taylor and Lewis, 1, 46: 1606; 24. (Dianthracene \rightarrow anthracene. Sensitive to red. Extinction measurements.) (166.5) Taylor, 83, 21: 560; 26. 7, 120: 183; 26. (Sensitization of C_2H_4 , CO , O_2 , N_2O with Hg .) (167) Thomas, Diss., Freiberg, 1908. (Oxidation of Na_2S , Cu_2Cl_2 , Cu_2Br_2 , Na_2SO_3 , $FeSO_4$, HI , pyrogallol. $CO + Br_2$. Retardation by radiation. Visible light.) (168) Tian, 34, 151: 1040; 10. 156: 1879; 13. (H_2O_2 . QQ. Monomolecular.) (169) Tian, 16, 5: 248; 16. (H_2O_2 . UV. Monomolecular. Effect of acids and bases. RV proportional to I . $2H_2O \rightarrow 2H_2 + O_2$. Kinetics. Effect of acids and bases.)
- (170) Tolman, 1, 42: 2506; 20. 45: 2285; 23. (TC. Theory.) (171) Tramm, 7, 105: 356; 23. ($3O_2 \rightleftharpoons 2O_3$, $H_2 + Cl_2 \rightleftharpoons 2HCl$, HBr , HI , $CO + Cl_2$, $SO_2 + Cl_2$, $CO + O$, $H_2 + O_2$. Extremely dry gases.) (172) Trautz, 63, 7: 899; 06. (Pyrogallol + O_2 , $Na_2S + O_2$. TC.) (173) Trautz, 9, 13: 550; 07. ($Na_2S + O_2$. Retardation by light.) (174) Trautz, 9, 21: 336; 15. (SO ,

- + Cl₂. QQ. Uviol lamp. Bimolecular. TC.) (175) Varahalu, Ram and Rao, 194, 1: 107; 24. (Phototropy of Hg compounds.) (176) Voimar, 34, 178: 697; 24. (Calculations of effective λ .) (177) Volmer and Riggert, 7, 100: 502; 22. (Anthracene dissolved in hexane. Splitting off of an electron. QQ. Equation for RV.) (178) Warburg, 76, 1918: 1228. (KNO₃. UV. Quantum sensitivity. Criticism by Anderson, 1, 46: 797; 24. cf. Robinson, 1, 46: 1834; 24.) (179) Weigert, 8, 24: 55; 07. (COCl₂ \rightleftharpoons CO + Cl₂. UV. Equilibrium at high temperature.)
- (180) Weigert, 8, 24: 243; 07. (Sensitizing gas reactions with Cl₂. UV.) (181) Weigert, 9, 14: 591; 08. (2O₃[+Cl₂] \rightarrow 3O₂. QQ. Glass filter. Equation for RV.) (182) Weigert, 7, 63: 458; 08. (Anthracene \rightarrow dianthracene. Calculations from earlier researches.) (183) Weigert, 7, 80: 78; 12. 9, 18: 654; 12. (2O₃ \rightarrow 3O₂. UV. Kinetics.) (184) Weigert, 99, 11: 381; 12. (Efficiency factor of absorbed energy.) (185) Weigert, *Nernst Festschrift*, 464; 12. (O₂ retardation. Calculations by Winther, 7, 108: 271; 24.) (186) Weigert, 25, 46: 815; 13. (O₃ + H₂. UV. Kinetics.) (187) Weigert and Bohm, 7, 90: 189; 15. (O₃ + H₂. UV. RV in relation to C. TC. Spectral effect not additive.) (188) Weigert and Kellermann, 7, 107: 1; 23. 76, 1922: 315; 9, 28: 456; 22. (H₂ + Cl₂. Draper effect.) (189) Weigert and Kummerer, 25, 46: 1207, 1884; 13. See also Kummerer, *Diss.*, Berlin, 1914. (*o*-Nitrobenzaldehyde \rightarrow *o*-nitrosobenzoic acid. λ = 405 and 366. Constant velocity at total absorption. RV proportional to I. TC ca. 1.)
- (190) Wigand, 7, 65: 442; 09. (S $\lambda \rightleftharpoons$ S μ . Arc lamp.) (191) Wigand, 7, 77: 423; 11. (S $\lambda \rightleftharpoons$ S μ . QQ. Glass filter. Solution and fusion.) (192) Wildermann, 7, 42: 257; 03. (CO + Cl₂. Acetylene lamp. Kinetics.) (193) Winther, 99, 7: 409; 09. 8: 197, 237; 10. 9: 205; 11. (Eder's solution. Catalysis. Color sensitivity. Mechanics.) (194) Winther, 99, 8: 135; 10. (Ferric oxalate. UV. Inversion.) (195) Winther, 99, 11: 60; 12. 9, 18: 138; 12. (Hg⁺⁺ + Fe⁺⁺ \rightleftharpoons Hg⁺ + Fe⁺⁺⁺. UV. Light accumulator.) (196) Winther, 137, 2: No. 1; 20. (H₂O₂ + K₄Fe(CN)₆. UV. Constant velocity.) (197) Winther, 137, 2: No. 2; 20. (HI + O₂. λ = 436 - 313. Autocatalysis.) (198) Winther and Oxholt-Howe, 99, 13: 89; 13. (Eder's solution, eosin. False equilibrium.) (199) Winther and Oxholt-Howe, 99, 14: 196; 14. (Organic Fe salts. λ = 436 - 313. Kinetics.)
- (200) Wittwer, 8, 94: 597; 55. 97: 304; 56. 106: 266; 59. (Cl₂ + H₂O. Daylight. Monomolecular. Criticism by Bunsen and Roscoe, 8, 96: 373; 55.) (201) Wurmser, 34, 171: 820; 20. (CO₂ assimilation. Daylight. Color sensitivity.)

THE ABSORPTION SPECTRA OF DYES

WALTER C. HOLMES

ARRANGEMENT, SYMBOLS, UNITS AND CONVENTIONS

The following tables are designed to supplement the tables of spectroscopic data on technical synthetic dyes supplied by Formánek and Grandmougin in their "Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege" and the review of the spectroscopy of natural coloring matters found in Kayser's "Handbuch der Spektroskopie."

The primary aim has been that of affording a ready means of ascertaining what data are available for any given coloring matter. With this end in view the selection of dyes has been made as comprehensive and the literature references as complete as possible. There have also been recorded numerous data on the spectral location of the maxima of absorption bands, under various conditions, in the ultra-violet, visible and infra-red, which will usually prove adequate to those interested in the identification of dyes or in the correlation of color and constitution. If a more complete qualitative or quantitative definition of the absorption is desired it may, in numerous instances, be obtained readily by consulting the references recorded.

Synthetic dyes have been arranged by classes in twelve tables and listed in the order of their constitutional formulae. Natural coloring matters have been listed in alphabetical sequence in Table 13. The dye formulae are followed by the scientific names of the coloring matters, supplemented, in some instances, by names of more common usage and by C. I. (Colour Index of the Society of Dyers and Colourists) numbers.

All absorption maxima in the ultra-violet and visible spectrum are recorded in terms of wave length in millimicrons. Italicized values refer to the principal bands and bracketed values to relatively insignificant bands. (The common bracketing of several values signifies multiple maxima in a single band.) The absorption data are followed by reference numbers to the source from which they were taken, together with further reference numbers to other literature on the dye in question which may prove of further interest. References followed by (q) contain data on the more definitely quantitative aspect of the absorption.

In instances in which various data of independent origin have been available the recorded values are those which have appeared the more reliable to the writer. The question of the dependence which may be placed upon the greater portion of the material presented is left to the discrimination of the reader. Since data

Les tables suivantes ont pour objet de compléter les tables des données spectroscopiques concernant les colorants synthétiques techniques présentées par Formánek et Grandmougin dans leur ouvrage "Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege" et la revue de la spectroscopie des matières colorantes naturelles, qui se trouve dans l'ouvrage de Kayser "Handbuch der Spektroskopie."

L'objectif principal a été celui de procurer un moyen rapide de s'assurer quelles données sont disponibles pour une matière colorante donnée. À cette fin la sélection des colorants a été faite aussi étendue et les références bibliographiques aussi complètes que possible. Il a aussi été mentionné un très grand nombre de données sur la position spectrale des maxima des bandes d'absorption, pour des conditions variées, dans l'ultra-violet, le visible et l'infra-rouge, qui se révéleront ordinairement suffisantes pour ceux qui s'occupent de l'identification des colorants ou de la corrélation entre la couleur et la constitution. Si une définition qualitative ou quantitative plus complète de l'absorption est désirée, celle-ci pourra être obtenue promptement dans bien des cas en consultant les références mentionnées.

Les colorants synthétiques ont été arrangés par classes en douze tables et sont inscrits en listes suivant l'ordre de leurs formules de constitution. Les matières colorantes naturelles ont été disposées dans l'ordre alphabétique dans la Table 13.

Les formules des colorants sont suivies des noms scientifiques des matières colorantes, complétés dans certains cas par les noms d'un usage plus courant, et les nombres C. I. (Colour Index of the Society of Dyers and Colourists). Tous les maxima d'absorption dans les spectres ultra-violet et visible sont exprimés en millimicrons. Les valeurs en italique concernent les bandes principales, et les valeurs entre crochets ont rapport à des bandes relativement insignifiantes. (Plusieurs valeurs comprises entre deux crochets signifient des maxima multiples dans une seule bande.) Les données d'absorption sont suivies de nombres de référence indiquant la source dont elles proviennent; d'autres nombres de référence mentionnés à la suite se rapportent à d'autres sources bibliographiques relatives aux colorants en question qui peuvent présenter par surcroît un certain intérêt. Les références suivies de (q) signifient la disponibilité de données au point de vue plus défini de l'aspect quantitatif de l'absorption.

available for a given dye are meager and difficult to locate, in general, and since any information may be of service, it has not been considered advisable to exclude any material of definite character.

Die folgenden Tafeln bilden eine Ergänzung (1) zu den Tafeln spektroskopischer Werte technischer synthetischer Farbstoffe, die von Formánek und Grandmougin in ihrem Werke "Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege" beigegeben sind. Sie ergänzen (2) die Zusammenstellung über die Spektroskopie natürlicher Farbstoffe, die Kayser in seinem "Handbuch der Spektroskopie" gegeben hat.

Das Hauptziel war, ein bequemes Mittel für die Feststellung zu schaffen, welche Werte für einen bestimmten färbenden Stoff zu Gebote stehen. Unter diesem Gesichtspunkte geschah die Auswahl der Farbstoffe so umfassend wie möglich und der Nachweis der Literatur möglichst vollständig. Dort wurden zahlreiche Angaben über die spektrale Lage der Maxima von Absorptionsbanden zusammengetragen und zwar für verschiedene Bedingungen: im sichtbaren, Ultraviolett und Infrarot. In der Regel werden sie sich als ausreichend erweisen für diejenigen Forscher, denen an der Identifizierung von Farbstoffen oder an der Beziehung von Farbe und Konstitution gelegen ist. Braucht man eine vollständigere qualitative oder quantitative Definition der Absorption, so ist sie in zahlreichen Fällen bequem zu erhalten, wenn man die gesammelten Literaturangaben einsieht.

Synthetische Farbstoffe sind nach Klassen in zwölf Tafeln angeordnet und in der Reihenfolge ihrer Konstitutionsformeln aufgeführt. Natürliche Farbstoffe sind in alphabetischer Folge in Tafel 13 gesammelt.

Den Formeln der Farbstoffe folgen die wissenschaftlichen Namen der färbenden Stoffe. Zur Ergänzung dienen in einigen Fällen mehr allgemein gebräuchliche Bezeichnungen und die C. I. Nummern (des "Colour Index of the Society of Dyers and Colourists"). Alle Absorptions-Maxima im Ultraviolett und im sichtbaren Spektrum sind in Millimikron angegeben. Kursiv (in Schrägschrift) gesetzte Werte beziehen sich auf die Hauptbanden, eingeklammerte Werte beziehen sich auf verhältnismässig unbedeutende Banden. (Das Zusammenklammern verschiedener Werte bedeutet mehrere Maxima in einer einzelnen Bande.) Auf die Absorptionswerte folgen die Nummern-Angaben anderer Literaturstellen für die in Rede stehenden Farbstoffe, die von weiterem Interesse sein können. Angaben, die mit einem (q) versehen sind, kennzeichnen die Brauchbarkeit von Werten für die mehr quantitative Betrachtung der Absorption.

In Fällen, in denen verschiedene Werte aus von einander unabhängigen Quellen zur Verfügung standen, hat der Herausgeber die ihm zuverlässiger erscheinenden Werte aufgenommen. Die Frage der Verlässlichkeit, die für einen grossen Teil des Stoffes gestellt werden kann, ist der Entscheidung des Lesers überlassen. Im allgemeinen sind die für einen bestimmten Farbstoff verfügbaren Werte so dürftig und auch so schwierig festzustellen—während auch der geringste Nachweis schon von Nutzen sein kann—dass es nicht ratsam erschien, irgendwelche Unterlagen bestimmten Charakters fortzulassen.

Dans le cas où des données diverses d'origines différentes ont été disponibles, les valeurs mentionnées sont celles qui ont paru les plus dignes de confiance au rédacteur. La question de la confiance, qui peut être placée dans la plus grande portion de la matière présentée, est laissée à la discrimination du lecteur. Comme les données disponibles pour un colorant donné sont en général peu abondantes et difficiles à trouver et comme chaque information peut être utile, il a été considéré comme judicieux de n'exclure aucune matière présentant un caractère défini.

Le seguenti tabelle sono compilate come complemento delle tabelle di dati spettroscopici sulle sostanze coloranti sintetiche di uso industriale dati da Formánek e Grandmougin nella loro "Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege" e sulle sostanze coloranti naturali contenute nel "Handbuch der Spektroskopie" di Kayser.

Il principale nostro scopo è stato quello di fornire un modo rapido per stabilire quali sono i dati dei quali si dispone per qualsiasi sostanza colorante. Tenendo presente questo fine si è tenuto conto del maggior numero possibile di sostanze coloranti, e si è riportato nel modo più completo la bibliografia. Abbiamo pure riportato un considerevole numero di dati sopra la posizione dei massimi nelle bande di assorbimento in diverse condizioni, nell'ultra-violetto, nel visibile e nell'infra-rosso, i quali dati potranno bastare per chi si interessa della identificazione dei coloranti o dei rapporti tra colore e costituzione. Se si vuole un quadro più completo, dal punto di vista qualitativo o quantitativo, dell'assorbimento, lo si può ottenere subito in molti casi consultando le citazioni riportate.

I coloranti sintetici sono stati disposti per classi in dodici tavole e ordinati in base alle loro formule di costituzione. Le sostanze coloranti naturali sono state messe in ordine alfabetico nella Tavola 13.

Le formule dei coloranti sono seguite dai nomi scientifici della sostanza colorante completati in alcuni casi con i nomi di uso più comune e con i numeri del C. I. (Colour Index of the Society of Dyers and Colourists). Tutti i massimi di assorbimento nell'ultra-violetto e nello spettro visibile sono riportati in millimicron. I valori in italici si riferiscono alle principali bande e i valori fra parentesi alle bande relativamente insignificanti. (Le parentesi comuni che racchiudono vari valori significano massimi multipli in una stessa banda.) I dati degli assorbimenti sono seguiti da numeri che si riferiscono alla memoria dalle quali sono stati presi insieme con altri numeri di riferimento ad altra letteratura sul colorante in questione, che può essere di ulteriore interesse. Quando una citazione è seguita da (q) significa che si hanno a disposizione dati quantitativi sull'assorbimento.

Nei casi nei quali si sono potuti avere dati di origine indipendente, i valori riportati sono quelli che sono sembrati i più attendibili al compilatore. La questione della fiducia che si può avere nella maggior parte dei dati riprodotti è lasciata al criterio del lettore. Siccome i valori ottenibili per un dato colorante sono in genere rari e difficili a rintracciare e siccome qualsiasi informazione può essere utile, non abbiamo creduto opportuno di escludere nessun dato di carattere definito.

ABBREVIATIONS

- AcO = $\text{C}_2\text{H}_3\text{COO}^-$
 HOAc = CH_3COOH
 AmOH = $\text{C}_6\text{H}_{11}\text{OH}$
 B. A. A. = Boric acid—acetic anhydride
 EtOH = $\text{C}_2\text{H}_5\text{OH}$
 S. B. A. = Sulfuric—boric acid

TABLES

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TABLE 1.—MONOAZO DYES

<p>$C_{10}H_8N_4O_2$.—<i>o</i>-Nitrobenzeneazopyrrole: 639 in EtOH (76). <i>m</i>-Nitrobenzeneazopyrrole: 560 in EtOH (76). <i>p</i>-Nitrobenzeneazopyrrole: 600 in EtOH (76). $C_{10}H_9N_3$.—Benzeneazopyrrole: 612 in EtOH (76). $C_{11}H_{10}N_4O_2$.—<i>p</i>-Nitrobenzeneazo-<i>N</i>-methylypyrrole: 635 in EtOH (76). $C_{12}H_6Br_4N_2O_2$.—Tetrabromo-<i>p</i>-azophenol: 476, 360 in EtOH (with both α- and β-isomers) (543). $C_{12}H_6N_8O_{12}$.—Hexanitrohydrazobenzene: 314 in $CHCl_3$; 493 in MeOH; 337 with HCl; 500 with NaOEt (224). $C_{12}H_7Br_2N_3O_3$.—<i>p</i>-Nitrobenzeneazo-<i>m</i>-dibromophenol: alkali salt, 555 in Me_2CO; 511 in EtOH; 493 in H_2O (643). $C_{12}H_7Br_3N_2O$.—<i>sym</i>.-Tribromobenzeneazophenol: 430, 384 in alk. H_2O (468). $C_{12}H_8BrN_3O_3$.—<i>p</i>-Nitrobenzeneazo-<i>p</i>-bromophenol: alkali salt, 550 in Me_2CO; 504 in EtOH; 498 in H_2O (643). <i>p</i>-Nitrobenzeneazo-<i>o</i>-bromophenol: alkali salt, 559 in Me_2CO; 502 in EtOH; 480 in H_2O (643). $C_{12}H_8ClN_3O_3$.—<i>p</i>-Nitrobenzeneazo-<i>m</i>-chlorophenol: alkali salt, 556 in Me_2CO; 501 in EtOH; 470 in H_2O (643). $C_{12}H_8N_4O_4$.—<i>p</i>-Dinitroazobenzene: 494 in H_2O (463). $C_{12}H_9BrN_2O$.—Benzeneazo-<i>o</i>-bromophenol: 436, 390 in alk. H_2O (468). <i>p</i>-Bromobenzeneazophenol: 445, 395 in alk. H_2O (468); cf. (595). $C_{12}H_9ClN_2O$.—Chlorobenzeneazophenol: data on <i>o</i>-, <i>m</i>- and <i>p</i>-isomers (596). $C_{12}H_9ClN_4$.—Azobenzenediazonium chloride: 340 in EtOH (260). $C_{12}H_9IN_2$.—<i>p</i>-Iodoazobenzene: 340 in EtOH (476, 294 with HCl) (260). $C_{12}H_9N_3O_3$.—<i>o</i>-Nitrobenzeneazophenol: 362, 235 in EtOH; 437, 240 in alk. H_2O (62); 356 in EtOH (465 with NaOEt) (31); 487, 440 in alk. H_2O (468); cf. (596q, 622). <i>m</i>-Nitrobenzeneazophenol: 350 in EtOH (459 with NaOEt) (31); 358, 245 in EtOH; 436, 262 in alk. H_2O (62); 480 in alk. H_2O (471); cf. (596q, 622). <i>p</i>-Nitrobenzeneazophenol: 380, 257 in EtOH; 478, 273, (237) in alk. H_2O (62); alkali salt, 556 in Me_2CO; 505 in EtOH; 475 in H_2O (643); cf. (31, 468, 501, 521, 595, 596q, 624). $C_{12}H_9N_3O_4$.—<i>o</i>-Nitrobenzeneazoresorcinol: abs. in visible and ultra-violet in neutral and alk. solns. (622). <i>m</i>-Nitrobenzeneazoresorcinol: abs. in visible and ultra-violet in neutral and alk. solns. (624). <i>p</i>-Nitrobenzeneazocatechol: abs. in visible and ultra-violet for neutral and alk. solns. (622). <i>p</i>-Nitrobenzeneazoresorcinol: alkali salt, 605 in Me_2CO; 570 in EtOH; 550 in H_2O (643); cf. (501, 624). <i>p</i>-Nitrobenzeneazohydroquinol: abs. in visible and ultra-violet for neutral and alk. solns. (622). $C_{12}H_9N_3O_5$.—<i>p</i>-Nitrobenzeneazopyrogallol: alkali salt, 528 in Me_2CO (643); cf. (623). <i>p</i>-Nitrobenzeneazophloroglucinol: abs. in visible and ultra-violet for neutral and alk. solns. (623).</p>	<p> $C_{12}H_9N_3O_6S$.—<i>p</i>-Nitrobenzeneazosulfocarbolate: alkali salt, 575 in Me_2CO; 514 in EtOH (643); data given in (501) are incorrect. $C_{12}H_{10}N_2$.—Azobenzene: 463, 312 in H_2O (suspension) (471); 444, (345), 317 in EtOH; 417, 280 in concd. HCl (59); 440 in H_2SO_4; 589 in fuming acid (diacid salt) (310). In EtOH, 455, 313 (84); (third band at 229) (393). Similar abs. in $CHCl_3$ (210) and in vapor form (532); cf. (26, 29, 111, 185q, 201q, 214, 220q, 231q, 385, 413, 516, 534q, 618). $C_{12}H_{10}N_2O$.—Azoxybenzene: 323 in EtOH and in vapor form (532). Metallic salts (225); cf. (533). <i>o</i>-Hydroxyazobenzene: 441, 390 in alk. H_2O; 480 in acid H_2O (468). <i>m</i>-Hydroxyazobenzene: 415, 380 in alk. H_2O (468). <i>p</i>-Hydroxyazobenzene (benzeneazophenol): 340, 315 in H_2O; 433, 395 with alkali; 490, 463 with acid (468); 429, 268 in alk. H_2O (62); 331 in HCl (618); 465, 248 in H_2SO_4 (210); 360 in EtOH (456, 320 with NaOEt); 348 in Et_2O (211); (470), 355, 235 in EtOH (62). Abs. in 30 organic solvents (12q). Abs. of various derivs. (185q, 220q); cf. (26, 111, 225, 469, 471, 475, 544, 595, 596q, 613q, 624). $C_{12}H_{10}N_2O_2$.—2, 2'-Dihydroxyazobenzene: 490 in alk. H_2O (471). 2, 4-Dihydroxyazobenzene (benzeneazoresorcinol): 483 in alk. H_2O (471); 488, 450 in H_2SO_4 (196); 408 in EtOH (352); cf. (624). 3, 3'-Dihydroxyazobenzene: 500, 475 in alk. H_2O (471). 3, 4-Dihydroxyazobenzene (benzeneazocatechol): 480, 430 in alk. H_2O (468); cf. (622). 2, 5-Dihydroxyazobenzene (benzeneazoquinol): abs. of neutral and alk. solns. in visible and ultra-violet (622). 2, 4'-Dihydroxyazobenzene: 490 in alk. H_2O (471). 3, 4'-Dihydroxyazobenzene: 480 in alk. H_2O (471). 4, 4'-Dihydroxyazobenzene: 473 in alk. H_2O, 360 in EtOH (463 with NaOEt) (619). $C_{12}H_{10}N_2O_3$.—2, 3, 4-Trihydroxyazobenzene: abs. in visible and ultra-violet in neutral and alk. solns. (623). 2, 4, 2'-Trihydroxyazobenzene: 540, 492 in alk. H_2O (471). 2, 4, 4'-Trihydroxyazobenzene: 528, 490 in alk. H_2O (471). 2, 4, 5-Trihydroxyazobenzene: 505, 440, 345 in alk. H_2O (471). 2, 4, 6-Trihydroxyazobenzene: 460, 410 in alk. H_2O (471); 490, 405 in H_2SO_4 (196); cf. (623). 3, 4, 4'-Trihydroxyazobenzene: 470, 535 in H_2O with Na_2CO_3; 470, 440 with $NaHCO_3$ (471). 3, 4, 5-Trihydroxyazobenzene: 515, 495, 420 in alk. H_2O (471). $C_{12}H_{10}N_2O_3S$.—Azobenzene-<i>p</i>-sulfonic acid: 432 in H_2O over pH range 1–12 (613q). $C_{12}H_{10}N_2O_4$.—2, 2', 4, 4'-Tetrahydroxyazobenzene: 575, 540, 462 in H_2O with $NaHCO_3$ (471). 2, 4, 3', 4'-Tetrahydroxyazobenzene: 585 in alk. H_2O (471). 3, 3', 4, 4'-Tetrahydroxyazobenzene: 680 in alk. H_2O (471). $C_{12}H_{10}N_2O_4S$.—<i>m</i>-Sulfobenzeneazophenol: 460, 410 in alk. H_2O (471). <i>p</i>-Sulfobenzeneazophenol: 440, 400 in alk. H_2O (471); cf. (595, 613). Benzeneazosulfocarbolate: 455 in alk. H_2O (468).</p>
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$C_{12}H_{10}N_2O_5S$.—*p*-Sulfobenzeneazocatechol: 520 with NaOH; 485 with Na_2CO_3 (471).
p-Sulfobenzeneazoresorcinol (C. I. 148): Na salt, 430 in H_2O (271); cf. (231q, 420q, 525q).
 $C_{12}H_{10}N_2O_6S$.—*p*-Sulfobenzeneazophloroglucinol: 490 in H_2SO_4 (196).
 $C_{12}H_{10}N_4O_2$.—3'-Nitro-4-aminoazobenzene: 518, 490 in acid H_2O (471).
 $C_{12}H_{11}N_3$.—*m*-Aminoazobenzene: 430 in H_2O (pH 1) (613); (495 in acid H_2O (471)).
p-Aminoazobenzene: 490 in acid H_2O (pH 1) (613); 420 in H_2SO_4 (diacid salt); 556 in fuming acid (triacid salt); 395, 250 in EtOH (300 with HCl) (310). Abs. of vapor (532); cf. (26, 260, 385, 463, 468, 469, 619).
Diazaminobenzene: 361, 235 in EtOH; abs. of vapor (532).
 $C_{12}H_{11}N_3O$.—Aminoazoxybenzene: 527 in acid H_2O (468).
3-Hydroxy-4'-aminoazobenzene: 490, 470 in acid H_2O ; 485, 430 in alk. H_2O (471).
p-Aminobenzeneazophenol: 385 in EtOH; 546, 354 in dil. HCl ; 467 in conc. HCl (diacid salt) (261).
 $C_{12}H_{11}N_3O_2$.—2-Amino-3', 4'-dihydroxyazobenzene: 478 in alk. H_2O ; 490, 460 in acid H_2O (471).
5-Amino-2, 4'-dihydroxyazobenzene: 460 in alk. soln. (473).
 $C_{12}H_{11}N_3O_3S$.—4-Sulfo-4'-aminoazobenzene (Aniline Orange): 485 in acid H_2O (pH 1) (613q); 448, (280) in dil. NaOH; 496 in dil. HCl (216).
 $C_{12}H_{12}N_2$.—Hydrazobenzene: 290, 245 in EtOH (413); 310 in $CHCl_3$ (534).
 $C_{12}H_{12}N_4$.—*p*-Diaminoazobenzene: 499 in acid H_2O (463); 603 in very dil. HOAc (monacid salt); 497, 310 in EtOH + 3% HCl (diacid salt); 410 in H_2SO_4 (triacid salt) (261).
Benzeneazo-*m*-phenylenediamine (hydrochloride, C. I. 20): Infra-red abs. (296). Acid salts (497); cf. (231q).
 $C_{13}H_9N_3O_4$.—*p*-Nitrobenzeneazosalicylaldehyde: alkali salt, 564 in Me_2CO ; 500 in EtOH; 478 in H_2O (643).
p-Nitrobenzeneazo-*p*-hydroxybenzaldehyde: alkali salt, 547 in Me_2CO ; 494 in EtOH; 470 in H_2O (643).
 $C_{13}H_9N_3O_5$.—*p*-Nitrobenzeneazosalicylic acid (C. I. 40): 609 in alk. Me_2CO ; 555 in alk. EtOH; 514 in alk. H_2O (643); cf. (501, 525q, 595).
p-Nitrobenzeneazo-*m*-hydroxybenzoic acid: alkali salt, 583 in Me_2CO ; 508 in EtOH; 474 in H_2O (643).
p-Nitrobenzeneazo-*p*-hydroxybenzoic acid: alkali salt, 566 in Me_2CO ; 505 in EtOH; 475 in H_2O (643).
 $C_{13}H_{10}ClN_3O_2$.—*p*-Nitrobenzeneazo-2-chloro-5-hydroxytoluene: alkali salt, 580 in Me_2CO ; 524 in EtOH; 505 in H_2O (643).
 $C_{13}H_{10}N_2O$.—Benzoylazobenzene: 294 in EtOH (?) (434).
 $C_{13}H_{10}N_2O_3$.—4-Hydroxy-2-carboxyazobenzene: 445, 395 in alk. H_2O (471).
4-Hydroxy-2'-carboxyazobenzene: 435, 385 in alk. H_2O (471).
 $C_{13}H_{10}N_2O_3$.—4-Hydroxy-3-carboxyazobenzene: 452, 402 in alk. H_2O (471).
4-Hydroxy-3'-carboxyazobenzene: 438, 388 in alk. H_2O (471).
4-Hydroxy-4'-carboxyazobenzene: 452, 402 in alk. H_2O (471).
 $C_{13}H_{10}N_2O_4$.—2, 4'-Dihydroxy-5-carboxyazobenzene: 475 in alk. soln. (473).
 $C_{13}H_{10}N_4O_4$.—*p*-Nitrobenzeneazosalicylamide: alkali salt, 525 in Me_2CO ; 480 in EtOH (643).
 $C_{13}H_{11}N_3O_3$.—*o*-Nitrobenzeneazo-*o*-cresol: 380, 238 in EtOH; 457, 273 in alk. H_2O (62).
o-Nitrobenzeneazo-*m*-cresol: 375, 240 in EtOH; 445, 278 in alk. H_2O (62).
o-Nitrobenzeneazo-*p*-cresol: abs. in visible and ultra-violet in neutral and alk. solns. (621).

m-Nitrobenzeneazo-*m*-cresol: 375, 257 in EtOH; 436, 273 in alk. H_2O (62).
m-Nitrobenzeneazo-*o*-cresol: 370, 255 in EtOH; 465, 276 in alk. H_2O (62).
m-Nitrobenzeneazo-*p*-cresol: abs. in visible and ultra-violet in neutral and alk. solns. (621).
p-Nitrobenzeneazo-*o*-cresol: 391, 273 in EtOH; 493, 287 in alk. H_2O (62); alkali salt, 590 in Me_2CO ; 530 in EtOH; 490 in H_2O (643); cf. (621).
p-Nitrobenzeneazo-*m*-cresol: 398, 266 in EtOH; 486, 286 in alk. H_2O (62); 585 in alk. Me_2CO ; 520 in alk. EtOH (643); cf. (501, 621).
p-Nitrobenzeneazo-*p*-cresol: alkali salt, 590 in Me_2CO ; 542 in EtOH; 499 in H_2O (643); cf. (94, 501).
 $C_{13}H_{11}N_3O_4$.—*p*-Nitrobenzeneazoguaiacol: alkali salt, 600 in Me_2CO ; 540 in EtOH; 510 in H_2O (643); cf. (501, 622).
p-Nitrobenzeneazosaligenin: alkali salt, 565 in Me_2CO ; 509 in EtOH; 483 in H_2O (643); cf. (501).
p-Nitrobenzeneazoorecinol: 539 in alk. Me_2CO (643).
p-Nitrobenzeneazoresorcinol methyl ether; alkali salt, 574 in Me_2CO ; 520 in EtOH; 493 in H_2O (643).
p-Nitrobenzeneazohydroquinol methyl ether: abs. in visible and ultra-violet in neutral and alk. solns. (622).
 $C_{13}H_{11}N_3O_7S$.—*p*-Nitrobenzeneazothiocol: alkali salt, 555 in Me_2CO ; 536 in EtOH; 510 in H_2O (643); cf. (501).
 $C_{13}H_{12}N_2O$.—Benzeneazo-*o*-cresol: (470), 358, 238 in EtOH; 450, 273 in alk. H_2O (62); cf. (621).
Benzeneazo-*m*-cresol: 352 in EtOH (431 with $NaOEt$); 481, 328 in HCl (618); (450), 358, 238 in EtOH; 412, 270 in alk. H_2O (62); cf. (621).
Benzeneazo-*p*-cresol: 316 in EtOH (488, 330 with $NaOEt$); 492, 406 in HCl (618); cf. (624).
Tolueneazophenol: abs. of isomers in visible and ultra-violet in neutral and alk. solns. (621); abs. of derivs. (220q).
 $C_{13}H_{12}N_2O_2$.—Benzeneazoguaiacol: 460 in alk. H_2O (468).
o-Tolueneazoresorcinol: 435 in EtOH (352); cf. (621).
m-Tolueneazoresorcinol: abs. in visible and ultra-violet in neutral and alk. solns. (621).
p-Tolueneazoresorcinol: 427 in EtOH (352); cf. (621).
p-Methoxybenzeneazophenol: 360 in EtOH (619).
p-Azoxyanisole: 355 in EtOH (533).
 $C_{13}H_{12}N_2O_4S$.—*p*-Sulfobenzeneazo-*o*-cresol: 463 in alk. H_2O (468).
p-Sulfobenzeneazo-*m*-cresol: 475 in alk. H_2O (468).
 $C_{13}H_{12}N_2S$.—Benzeneazothioanisole: 365 in EtOH (160).
 $C_{13}H_{12}N_4O_3$.—*p*-Nitrobenzeneazo-*o*-methylaminophenol: alkali salt, 635 in Me_2CO ; 573 in EtOH; 550 in H_2O (643).
 $C_{13}H_{13}N_3$.—Benzeneazo-*o*-toluidine: 505, 308 in 2*N* HCl ; 392 in EtOH (216).
 $C_{13}H_{13}N_3O_3S$.—*p*-Sulfobenzeneazo-*o*-toluidine (*o*-Toluidine Orange): 491 in dil. HCl (613q); 414, (280) in dil. NaOH; 488, (319) in dil. HCl (216).
m-Sulfobenzeneazo-*m*-toluidine (*m*-Toluidine Orange): 483 in dil. acid (613q); 414, (280) in dil. NaOH; 501, (320) in dil. HCl (216).
4-Sulfo-4'-methylaminoazobenzene (Monomethyl Orange): 500 in acid soln. (pH 1); 454 in alk. soln. (pH 12) (613q); 453, (280) in dil. NaOH; 506 in dil. HCl (216).
 $C_{13}H_{11}N_3O_5$.—*p*-Nitrobenzeneazovanillin: alkali salt, 572 in Me_2CO ; 525 in EtOH; 509 in H_2O (643).
 $C_{14}H_{11}N_3O_4$.—*p*-Nitrobenzeneazohomosalicylaldehyde: alkali salt, 595 in Me_2CO ; 546 in EtOH; 525 in H_2O (643).
 $C_{14}H_{11}N_3O_5$.—*p*-Nitrobenzeneazomethylsalicylate: alkali salt, 530 in Me_2CO ; 485 in EtOH; 467 in H_2O (643).
p-Nitrobenzeneazo-*o*-cresotic acid: alkali salt, 535 in Me_2CO ; 530 in EtOH; 512 in H_2O (643).

$C_{14}H_{11}N_3O_5$.—*p*-Nitrobenzeneazo-*m*-cresotic acid: alkali salt, 544 in Me_2CO ; 525 in EtOH; 508 in H_2O (643).

p-Nitrobenzeneazo-*p*-cresotic acid: alkali salt, 579 in Me_2CO ; 535 in EtOH; 515 in H_2O (643).

$C_{14}H_{12}N_2O_2$.—*p*-Acetylbenzeneazophenol: 370 in EtOH; 476 in NaOH soln. (258).

$C_{14}H_{13}N_3O$.—*p*-Acetylaminoazobenzene: 345 in EtOH (619); cf. (385).

$C_{14}H_{13}N_3O_2$.—*m*-Acetylamino-*o*-hydroxyazobenzene (385).

$C_{14}H_{13}N_3O_4$.—*p*-Nitrobenzeneazocresol: alkali salt, 602 in Me_2CO ; 545 in EtOH; 512 in H_2O (643).

$C_{14}H_{14}N_2O$.—Benzeneazophenetole: 340 in EtOH; 474, 331 in HCl (618).

o-Tolueneazocresol: abs. of cresol isomers in visible and ultra-violet in neutral and alk. solns. (620).

m-Tolueneazocresol: abs. of cresol isomers in visible and ultra-violet in neutral and alk. solns. (620).

p-Tolueneazocresol: abs. of cresol isomers in visible and ultra-violet in neutral and alk. solns. (620). *p*-Cresol isomer: 327 in EtOH (481, 334 with NaOEt); 505, 427 in HCl (618).

$C_{14}H_{14}N_2O_2$.—*o*, *o'*-Azoanisole: 490 in HOAc-HCl soln. (549).

p, *p'*-Azoanisole: 500 in HOAc-HCl soln. (549).

p-Ethoxybenzeneazophenol: 447, 390 in alk. H_2O (468).

$C_{14}H_{14}N_2O_4S$.—2, 6-Dimethyl-4-hydroxy-4'-sulfoazobenzene: influence of pH (613q).

$C_{14}H_{14}N_2S_2$.—*o*, *o'*-Azophenylmethylsulfide: 620 in HOAc-HCl soln. (549).

p, *p'*-Azophenylmethylsulfide: 577 in HOAc-HCl soln. (549).

$C_{14}H_{14}N_3O_3$.—*p*-Nitrobenzeneazo-2-hydroxy-1, 3-dimethylbenzene: alkali salt, 610 in Me_2CO ; 558 in EtOH; 517 in H_2O (643).

p-Nitrobenzeneazo-2-hydroxy-1, 4-dimethylbenzene: alkali salt, 599 in Me_2CO ; 544 in EtOH; 510 in H_2O (643).

p-Nitrobenzeneazo-4-hydroxy-1, 2-dimethylbenzene: alkali salt, 600 in Me_2CO ; 540 in EtOH; 510 in H_2O (643).

p-Nitrobenzeneazo-4-hydroxy-1, 3-dimethylbenzene: alkali salt, 605 in Me_2CO ; 553 in EtOH; 513 in H_2O (643).

$C_{14}H_{14}N_4O_2$.—*m*-Nitrobenzeneazodimethylaniline: 467 in EtOH (31).

p-Nitrobenzeneazodimethylaniline: 483, 277 in EtOH (31).

$C_{14}H_{14}N_4O_3$.—*p*-Nitrobenzeneazo-*m*-dimethylaminophenol: alkali salt, 596 in Me_2CO ; 564 in EtOH; 530 in H_2O (643).

$C_{14}H_{15}N_3$.—*p*-Dimethylaminoazobenzene (C. I. 19): 508 in acid soln. (pH 1); 450 in alk. soln. (pH 13) (613q); 545, 507 in 3% HCl; 420 in H_2SO_4 (diacid salt); 607 in fuming acid (triacid salt); 410 in EtOH; 550, 511, 300 in EtOH + 3% HCl (310); 405, 375 in H_2O ; 490, 460 with alkali; 543, 508 with acid (469); cf. (26, 111, 210, 214, 218, 423q, 468, 475, 619).

$C_{14}H_{15}N_3O$.—*p*-Dimethylaminobenzeneazophenol: 413 in EtOH; 550, 341 in dil. HCl; 477, 314 in HCl (diacid salt) (261).

p-Dimethylaminoazoxybenzene: 545 in acid H_2O (471).

2-Dimethylamino-4-hydroxyazobenzene: 486, 463 in alk. H_2O (471).

4-Dimethylamino-2-hydroxyazobenzene: 492, 463 in alk. H_2O ; 503, 473 in acid H_2O (471).

$C_{14}H_{15}N_3O_3S$.—*p*-Sulfobenzeneazodimethylaniline (Na salt, C. I. 142, Methyl Orange): 506 in acid soln. (pH 1), 472 in alk. soln. (pH 13) (613q); 442 in EtOH; 481, 281 in H_2O ; 465, 280 in *N* NaOH; 508, (333), 283 in dil. HCl (469); cf. (208, 231, 269, 473, 525, 583q, 612, 647).

m-Sulfobenzeneazodimethylaniline: 535, 490 in acid H_2O (471).

o-Sulfobenzeneazodimethylaniline: 510 in acid soln. (pH 1); 435 in alk. soln. (pH 13); 516 in 6*N* HCl (613q).

p-Sulfobenzeneazoethylaniline: 498 in acid soln. (pH 1); 442 in alk. soln. (pH 12) (613q); 493 in dil. HCl; 453, (280) in dil. NaOH (216).

2, 5-Dimethyl-4-amino-4'-sulfoazobenzene: 490 in acid H_2O (613q).

3, 5-Dimethyl-4-amino-4'-sulfoazobenzene: 500 in acid H_2O (613q).

$C_{14}H_{16}N_2O_2$.—Benzeneazodimethyldihydroresorcinol: 394, 246 in EtOH (472, 349, 283 with NaOEt) (380).

$C_{14}H_{16}N_4$.—Anilineazodimethylaniline: 513, 306, 256 in EtOH with 0.1*N* HCl (214); cf. (473).

$C_{15}H_{10}N_2O_3$.—Benzeneazocarbonylcoumaranone: 417, 250 in EtOH (368, 286 with NaOEt) (abs. of acetyl deriv. also described) (434).

$C_{15}H_{11}N_3O$.—Quinolineazophenol: 380 in EtOH (159).

5-Benzeneazo-8-hydroxyquinoline: 376 in EtOH; 518, 256 in HCl (159).

$C_{15}H_{12}N_4O$.—5-*p*-Aminobenzeneazo-8-hydroxyquinoline: 412 in EtOH (159).

$C_{15}H_{13}N_3O_5$.—*p*-Nitrobenzeneazoethylsalicylate: alkali salt, 531 in Me_2CO ; 490 in EtOH; 465 in H_2O (643).

$C_{15}H_{15}N_3O_2$.—2-Carboxy-4-dimethylaminoazobenzene: 549, 503 (471).

3-Carboxy-4-dimethylaminoazobenzene: 531, 497 (471).

2'-Carboxy-4-dimethylaminoazobenzene (Methyl Red, C. I. 211): 517 in pH 1 soln.; 530 in pH 4.5 soln.; 447 in pH 13 soln. (613q); 530 in alk. soln. (58q) (double band, 548, 514 (469)); cf. (433, 471, 612q).

3'-Carboxy-4-dimethylaminoazobenzene: 538, 503 (471).

4'-Carboxy-4-dimethylaminoazobenzene: 512 in acid soln. (pH 1); 463 in alk. soln. (pH 13) (613q); 539, 495 (471).

$C_{15}H_{16}N_2O$.—Benzeneazo-*m*-cresetole: 348 in EtOH (479, 331 with NaOEt) (618).

Benzeneazo-*p*-cresetole: 313 in EtOH; 500, 410 in HCl (618).

$C_{15}H_{17}N_3$.—Benzeneazodimethyl-*o*-toluidine: 347 in EtOH; 493, 250 in 2*N* HCl (216).

$C_{15}H_{17}N_3O$.—2-Methoxy-4-dimethylaminoazobenzene: 575, 532 in acid H_2O (471).

4'-Methoxy-4-dimethylaminoazobenzene: 412 in EtOH; 510, 351 in dil. HCl; 473, 323 in HCl (diacid salt) (261); 549, 350, 200 in 0.1*N* HCl (214).

$C_{15}H_{17}N_3O_3S$.—*p*-Sulfobenzeneazodimethyl-*o*-toluidine: 374 in EtOH; 447, 311 in HCl (216).

$C_{15}H_{17}N_3O_4S$.—*m*-Methoxymethyl orange: 510, 480 (473).

$C_{15}H_{18}N_2O_2$.—Benzeneazodimethyldihydroresorcinol methyl ether: 379, 244 in EtOH (380).

$C_{15}H_{18}ClN_3$.—Azobenzenetrimethylammonium chloride: 448, 312 (216).

$C_{15}H_{18}IN_3$.—Azobenzenetrimethylammonium iodide: 437, 314 in EtOH; 498, (314) in EtOH + 1% HCl; 428 in H_2SO_4 ; (500), 435 in HCl (26); cf. (210, 260).

$C_{16}H_{16}BrN_3O_3$.—4'-Nitrobenzeneazo-2-bromo-1-naphthol: 608 in alk. EtOH (473).

$C_{16}H_{11}BrN_2O$.—*p*-Bromobenzeneazo- α -naphthol: 470 in EtOH; K salt, 476 in EtOH (595).

$C_{16}H_{11}N_3O_3$.—*o*-Nitrobenzeneazo- α -naphthol: 476 in EtOH (540 with NaOEt) (31).

m-Nitrobenzeneazo- β -naphthol (*m*-Nitroaniline Orange, C. I. 38): 557.6, 524.1 in H_2SO_4 (190).

p-Nitrobenzeneazo- α -naphthol: alkali salt, 630 in Me_2CO ; 590 in EtOH; 568 in H_2O (643); (602), 576, (552) in H_2O ; (623), 598, (572) in EtOH (468); cf. (501).

p-Nitrobenzeneazo- β -naphthol (*p*-Nitroaniline Red, C. I. 44): 578.3, 541.3 in H_2SO_4 (352); alkali salt, 587 in Me_2CO ; 555 in EtOH (643); cf. (501).

$C_{16}H_{12}N_2O$.—Benzeneazo- α -naphthol: 496 in alk. H_2O (468); 469, 405 in EtOH (29); 490, 406, 275 in EtOH (352); 585 in H_2SO_4 (196); cf. (595).

$C_{16}H_{12}N_2O$.—Benzeneazo- β -naphthol (Sudan I, C. I. 24): 514, 311 in EtOH; 311 in H_2SO_4 (352); 563, 517 in H_2SO_4 (196); cf. (423q, 619).

$C_{16}H_{12}N_2O_2$.—Benzeneazo-1, 5-dihydroxynaphthalene: 540 in alk. EtOH (174).

Benzeneazo-2, 7-dihydroxynaphthalene: 545, 498 in H_2SO_4 (196).

p-Hydroxybenzeneazo- α -naphthol: 490 in alk. EtOH (174).

p-Hydroxybenzeneazo- β -naphthol: 610, 490 in alk. EtOH (174).

$C_{16}H_{12}N_2O_3$.—*p*-Hydroxybenzeneazo-1, 3-dihydroxynaphthalene: 490 in alk. EtOH (174).

p-Hydroxybenzeneazo-1, 5-dihydroxynaphthalene: 550 in alk. EtOH (174).

p-Tolueneazocarbonylcoumaranone: 431, 253 in EtOH (369, 288 with NaOEt) (434).

$C_{16}H_{12}N_2O_4S$.—Benzeneazo- α -naphthol-2-sulfonic acid: Na salt, (424q).

Benzeneazo- α -naphthol-4-sulfonic acid: 547, 500 in H_2SO_4 (196).

Benzeneazo- β -naphthol-5-sulfonic acid: 525, 493 in H_2SO_4 (196).

Benzeneazo- β -naphthol-6-sulfonic acid: 526.5, 495 in H_2SO_4 (196); Na salt, 493, 315 in H_2O (352).

Benzeneazo- β -naphthol-7-sulfonic acid: 534 in H_2SO_4 (196).

Benzeneazo- β -naphthol-8-sulfonic acid: 522, 495 in H_2SO_4 (196).

p-Sulfobenzeneazo- α -naphthol (Orange I, C. I. 150): 476, 267, 232 in H_2O (179q); cf. (231q, 420q, 422q, 468, 519q, 595).

p-Sulfobenzeneazo- β -naphthol (Orange II, C. I. 151): 490 in H_2O (271); cf. (231q).

$C_{16}H_{12}N_2O_5S$.—*m*-Sulfo-*o*-hydroxybenzeneazo- β -naphthol (Na salt, C. I. 169), Pontachrome Violet S. W.: 548 in H_2O (concd.), 515 (dil.) (269).

$C_{16}H_{12}N_2O_7S_2$.—Benzeneazo- α -naphthol-4, 8-disulfonic acid: 557, 500 in H_2SO_4 (196).

Benzeneazo- β -naphthol-3, 6-disulfonic acid (Na salt, Orange R, C. I. 28): 528, 496 in H_2SO_4 (196); 500, 321 in H_2O (352); cf. (231q).

Benzeneazo- β -naphthol-6, 8-disulfonic acid (Na salt, Orange G, C. I. 27): 503, 487 in H_2SO_4 (196); 491, 320 in H_2O (352); cf. (162, 271).

p-Sulfobenzeneazo- α -naphthol-2-sulfonic acid: Na salt (424q).

$C_{16}H_{12}N_2O_8S_2$.—Benzeneazo-1, 8-dihydroxynaphthalene-3, 6-disulfonic acid (Na salt, C. I. 29, Chromotrop 2R): 510 in H_2O (271).

$C_{16}H_{12}N_2O_8S_2$.—*p*-Hydroxybenzeneazo- α -naphthol-3, 6-disulfonic acid: 560, 494 (473).

$C_{16}H_{12}N_2O_9S_2$.—1-Hydroxy-3, 6-sulfonaphthaleneazoresorcinol: 491 in alk. soln.; 545, 491 in acid soln. (473).

$C_{16}H_{12}N_4O_2$.—2-(4'-Nitrobenzeneazomethylene)-1, 2-dihydroquinoline: 545 in EtOH; 527 in H_2SO_4 ; hydrochloride, 460 in EtOH; data given for isomeric phenylhydrazones (341).

$C_{16}H_{12}N_4O_5S_2$.—2-*p*-Nitrobenzeneazo-1-amino-8-naphthol-3, 6-disulfonic acid: 522 in 1% HCl; 556 in 1% NaOH; 584 in 10% NaOH; 535 in H_2O (60q).

$C_{16}H_{13}N_3$.—Benzeneazo- α -naphthylamine: 293 in H_2SO_4 (352).

Benzeneazo- β -naphthylamine (Oil Yellow A. B., C. I. 22): 585 in H_2SO_4 (196); 453, 322 in H_2SO_4 ; 474, 306 in EtOH (352); cf. (423q).

$C_{16}H_{13}N_3O$.—*p*-Hydroxybenzeneazo- β -naphthylamine: 565 in alk. EtOH (174).

$C_{16}H_{13}N_3O_3S$.—Benzeneazo- β -naphthylamine-5-sulfonic acid: 543, 498 in H_2SO_4 (196).

Benzeneazo- β -naphthylamine-6-sulfonic acid: 545, 495 in H_2SO_4 (196).

Benzeneazo- β -naphthylamine-7-sulfonic acid: 545, 495 in H_2SO_4 (196).

$C_{16}H_{13}N_3O_4S$.—*o*-Aminosulfobenzeneazo- β -naphthol: 567.5, 537 (123).

m-Aminosulfobenzeneazo- β -naphthol: 556.3, 526 (123).

p-Aminosulfobenzeneazo- β -naphthol: 563, 533.3 (123).

$C_{16}H_{13}N_3O_6S$.—1-Amino-4-sulfo-2-naphtholazoresorcinol: 640, 590.5, 550 in alk. soln.; 583.5, 543, 513.5 in acid soln. (123).

1-Amino-6-sulfo-2-naphtholazoresorcinol: 560, 510, 472 in H_2O ; 625, 582, 540 with NH_4OH (123).

1-Amino-7-sulfo-2-naphtholazoresorcinol: 566, 520, 481 in H_2O ; 633, 588, 546 with NH_4OH (123).

1-Amino-8-sulfo-2-naphtholazoresorcinol: 547, 514 in H_2O ; 610, 568, 530 with NH_4OH (123).

2-Amino-3-sulfo-1-naphtholazoresorcinol: 560, 483 in H_2O ; 630, 541.5, 502.5 with NH_4OH (123).

2-Amino-4-sulfo-1-naphtholazoresorcinol: 561, 518, 478 in H_2O ; 528 with NH_4OH (123).

2-Amino-5-sulfo-1-naphtholazoresorcinol: 574, 529, 476 in H_2O ; 586, 541 with NH_4OH (123).

$C_{16}H_{13}N_3O_6S_2$.—Benzeneazo- β -naphthylamine-3, 6-disulfonic acid: 539, 495 in H_2SO_4 (196).

$C_{16}H_{13}N_3O_7S$.—2-Amino-4-sulfo-1, 8-dihydroxynaphthaleneazoresorcinol: 518 in alk. soln. (123).

$C_{16}H_{13}N_3O_7S_2$.—Benzeneazo-1, 8-aminonaphthol-3, 6-disulfonic acid: 541 in NaOH; 529, 494 in HCl; 545, 502 in HOAc (473); 495 in 10% NaOH; 530 in H_2O (60).

2, 4-Disulfo-1-aminobenzeneazo- β -naphthol: 507.5, 483 in H_2O ; 560, 528.5 in H_2SO_4 ; 505, 479.5 in EtOH (123).

2, 5-Disulfo-1-aminobenzeneazo- β -naphthol: 509.5, 478 in H_2O ; 562, 538 in H_2SO_4 ; 502, 479.5 in EtOH (123).

$C_{16}H_{13}N_3O_9S_2$.—1-Amino-3, 6-disulfo-2-naphtholazoresorcinol: 566.5, 526, 486.5 in H_2O ; 635, 586.5, 550 with NH_4OH (123).

1-Amino-6, 8-disulfo-2-naphtholazoresorcinol: 543, 508.2 in H_2O ; 611.5, 536, 497 with NH_4OH (123).

2-Amino-3, 6-disulfo-1-naphtholazoresorcinol: 569, 537.5, 502 in H_2O ; 635, 582.5 with NH_4OH (123).

2-Amino-3, 8-disulfo-1-naphtholazoresorcinol: 564, 480.5 in H_2O ; 637.5, 588 with NH_4OH (123).

2-Amino-4, 8-disulfo-1-naphtholazoresorcinol: 560, 523, 483 in H_2O ; 629, 560 with NH_4OH (123).

$C_{16}H_{13}N_3O_{10}S_2$.—2-Amino-3, 6-disulfo-1, 8-dihydroxynaphthaleneazoresorcinol: 564.5, 537 in alk. soln.; 591.5, 549.5 in acid soln. (123).

$C_{16}H_{13}N_3O_{12}S_3$.—1-Amino-3, 6, 8-trisulfo-2-naphtholazoresorcinol: 555, 521 in H_2O ; 626.5, 578, 541.5 with NH_4OH (123).

$C_{16}H_{15}BrN_2O$.—*p*-Bromobenzene-1-azo-1', 2', 3', 4'-tetrahydro-4-naphthol: K salt, 476 in EtOH (595).

$C_{16}H_{15}N_3O_3$.—*p*-Nitrobenzene-1-azo-1', 2', 3', 4'-tetrahydro-4-naphthol: K salt, 581 in EtOH (595).

$C_{16}H_{15}N_3O_4$.—*p*-Nitrobenzeneazoeugenol: alkali salt, 610 in Me_2CO ; 556 in EtOH; 535 in H_2O (643); cf. (501).

$C_{16}H_{16}N_2O$.—Benzeneazotetrahydro- α -naphthol: 470, 430 in alk. H_2O ; 471 in EtOH (595).

$C_{16}H_{17}N_3O_3$.—*p*-Nitrobenzeneazocarvacrol: alkali salt, 606 in Me_2CO ; 545 in EtOH; 511 in H_2O (643); cf. (501).

p-Nitrobenzeneazothymol: alkali salt, 610 in Me_2CO ; 559 in EtOH; 515 in H_2O (643); cf. (501).

$C_{16}H_{18}ClN_3O_3S$.—2-Chloro-4-diethylamino-4'-sulfoazobenzene: 510 in acid soln. (pH 1); 470 in alk. soln. (pH 12) (613q).

$C_{16}H_{18}N_2O$.—Benzeneazothymol: 455, 410 in alk. H_2O (468).

p-Tolueneazo-*p*-cresetole: 325 in EtOH; 495, 420 in HCl (618).

$C_{16}H_{18}N_2O_2$.—Azophenetole: 384 in EtOH (431 with NaOEt) (619).

$C_{16}H_{18}N_2O_3$.—*p*-Azoxyphenetole: 360 in EtOH (533).

$C_{16}H_{18}N_2O_5S$.—*o*-Methyl-*m*-isopropyl-*p*-sulfobenzeneazoresorcinol: Na salt, 440 in H_2O (271).

$C_{16}H_{18}N_4O$.—4-Acetyl-amino-4'-dimethylaminoazobenzene: 540 (473).

- $C_{16}H_{19}N_3O$.—4-Ethoxy-4'-dimethylaminoazobenzene: 548 (473).
- $C_{16}H_{19}N_3O_3S$.—4-Diethylamino-4'-sulfoazobenzene (Ethyl Orange): 510 in acid soln. (pH 1); 470 in alk. soln. (pH 13) (613q).
- $C_{16}H_{19}N_3O_5S$.—2, 2'-Dimethoxy methyl orange: 537, 495 (473).
- $C_{16}H_{26}N_4$.—Tetramethyl-*p*-diaminoazobenzene: 450 in EtOH; 692, (514), 450 in dil. HOAc; 530, 497 in 3% HCl (diacid salt); (498), 410 in H_2SO_4 (triacid salt) (310); cf. (475).
- $C_{17}H_{13}N_3O_5$.—*p*-Nitrobenzeneazo-*n*-butylsalicylate: alkali salt, 556 in Me_2CO ; 496 in EtOH; 480 in H_2O (643).
- p*-Nitro- α -naphthaleneazosalicylie acid: K salt, 541 in EtOH (595).
- $C_{17}H_{12}N_2O_6S$.—*o*-Carboxybenzeneazo- α -naphthol-2-sulfonic acid: Na salt (424q).
- $C_{17}H_{13}N_3O_3$.—*o*-Nitro-*p*-tolueneazo- β -naphthol (Toluidine Red, C. I. 69): 569.4, 533.2 in H_2SO_4 (190); 561 in gelatin (114).
- $C_{17}H_{14}N_2O$.—*o*-Tolueneazo- α -naphthol: 406, 275 in EtOH (352).
- o*-Tolueneazo- β -naphthol: 515, 313 in EtOH; 313 in H_2SO_4 (352).
- p*-Tolueneazo- α -naphthol: 402 in EtOH; 300 in H_2SO_4 (352).
- p*-Tolueneazo- β -naphthol: 495, 312 in EtOH (352).
- $C_{17}H_{14}N_2O_4S$.—*o*-Tolueneazo- β -naphthol-6-sulfonic acid: Na salt, 496, 316 in H_2O ; 311 in H_2SO_4 (352).
- p*-Tolueneazo- β -naphthol-6-sulfonic acid: Na salt, 498, 316 in H_2O (352).
- o*-Tolueneazo- α -naphthol-2-sulfonic acid: Na salt (424q).
- p*-Tolueneazo- α -naphthol-2-sulfonic acid: Na salt (424q).
- $C_{17}H_{14}N_2O_5S$.—2-Anisoleazo- α -naphthol-6-sulfonic acid (Na salt, Anisole Red): 522 in gelatin (114).
- $C_{17}H_{14}N_2O_7S_2$.—*o*-Tolueneazo- β -naphthol-3, 6-disulfonic acid: Na salt, 503, 323 in H_2O (352).
- o*-Tolueneazo- β -naphthol-6, 8-disulfonic acid: Na salt, 491, 324 in H_2O ; 320 in H_2SO_4 (352).
- p*-Tolueneazo- β -naphthol-3, 6-disulfonic acid: Na salt, 500, 322 in H_2O (352).
- p*-Tolueneazo- β -naphthol-6, 8-disulfonic acid: Na salt, 497, 323 in H_2O (352).
- $C_{17}H_{14}N_4O_2$.—1-Methyl-2-(4'-nitrobenzeneazomethylene)-1, 2-dihydroquinoline: hydrochloride, 527 in H_2SO_4 (343).
- $C_{17}H_{15}N_3$.—*o*-Tolueneazo- α -naphthylamine: 298 in H_2SO_4 (352).
- o*-Tolueneazo- β -naphthylamine (Oil Yellow OB, C. I. 61): 474, 306 in EtOH; 455, 323 in H_2SO_4 (352); cf. (220q).
- p*-Tolueneazo- β -naphthylamine: 473, 305 in EtOH; 323 in H_2SO_4 (352).
- $C_{17}H_{16}N_4O_2$.—2-(4'-Nitrobenzeneazomethylene)-3, 3-dimethylindoline: hydrochloride, 469 in HOAc (347).
- $C_{17}H_{17}N_3$.—2-(Benzeneazomethylene)-3, 3-dimethylindoline: hydrochloride, 465; base, 435 (347).
- $C_{17}H_{19}N_3O_2$.—2-Carboxy-4'-diethylaminoazobenzene: 512 in pH 1 soln.; 522 in pH 4 soln.; 499 in pH 12 soln. (613q).
- 4-Dimethylamino-4'-ethylearboxyazobenzene: 444, 275 in EtOH (214).
- $C_{18}H_{12}N_4O$.—Quinolineazo-8-hydroxyquinoline: 403 in EtOH (159).
- $C_{18}H_{14}N_2O$.—Diphenylazophenol: 451 in alk. H_2O (468).
- $C_{18}H_{14}N_2O_2$.—*p*-Hydroxydiphenylazophenol; monobasic salt, 492 ($NaHCO_3$); dibasic salt, 470 ($NaOH$) (463).
- Benzenazo- α -naphthyl acetate: 376 in EtOH (619).
- Benzenazo- β -naphthyl acetate: 472, 282 in EtOH (619).
- p*-Acetylbenzeneazo- α -naphthol: 467, 315 in EtOH; 526, 300 in $NaOH$ (258).
- p*-Acetylbenzeneazo- β -naphthol: 476, 318 in EtOH; 513, 286 in $NaOH$ (258).
- $C_{18}H_{14}N_2O_6S$.—*o*-Methylcarboxybenzeneazo- α -naphthol-2-sulfonic acid: Na salt (424q).
- $C_{18}H_{15}N_3O_3S$.—4-Phenylamino-4'-sulfoazobenzene (Na salt, C. I. 143): 527 in pH 1 soln.; 456 in pH 12 soln. (613q).
- $C_{18}H_{15}N_3O_5S_2$.—Benzeneazo-8-acetylamino-1-naphthol-3, 6-disulfonic acid (Na salt, C. I. 31): Kiton Red G (22).
- $C_{18}H_{16}N_2O$.—Benzeneazo- α -naphthol ethyl ether: 400 in EtOH (619).
- $C_{18}H_{17}N_3$.—Benzeneazodimethyl- α -naphthylamine: 570, 525 in acid H_2O (471).
- $C_{18}H_{17}N_3O_3S$.—4-Sulfonaphthaleneazodimethylaniline: (473).
- $C_{18}H_{18}N_4O_3$.—2-(4'-Nitro-2'-methoxybenzeneazomethylene)-3, 3-dimethylindoline: hydrochloride, 484 in HOAc (347).
- $C_{19}H_{14}N_2O_2$.—*p*-Benzoylbenzeneazophenol: 481, 333 in EtOH (?) (471); 370 in EtOH; 476 in $NaOH$ (258).
- $C_{19}H_{14}N_4O_2$.—*p*-Nitrobenzylideneaminoazobenzene: 383 in EtOH (521).
- $C_{19}H_{15}N_3$.—Benzylideneaminoazobenzene: 383 in EtOH (521).
- $C_{19}H_{15}N_3O$.—*p*-Hydroxybenzylideneaminoazobenzene: 375 in EtOH (521).
- $C_{19}H_{17}N_3O_3S$.—*p*-Sulfobenzeneazobenzylaminobenzene: 448, (280) in dil. $NaOH$; 496 in dil. HCl (216); 560 in pH 1 soln. (613q).
- $C_{19}H_{18}N_2O_7S_2$.—Pseudoeumeneazo- β -naphthol-3, 6-disulfonic acid (Na salt, C. I. 80): 504, 330 in H_2O (179q); cf. (422q).
- $C_{19}H_{19}N_3O$.—2-(4'-Acetylbenzeneazomethylene)-3, 3-dimethylindoline: hydrobromide, 456 in EtOH (347).
- $C_{19}H_{19}N_3O_4S$.—*p*-Sulfo-*o*-methoxybenzeneazodimethyl- α -naphthylamine: 580, 525, 500 in acid H_2O (595).
- $C_{19}H_{20}N_4O_2$.—2-(4'-Nitrobenzeneazomethylene)-3, 3-diethylindoline: hydrochloride, 472 in HOAc (347).
- $C_{20}H_{13}BrN_2O$.—*p*-Bromobenzene-1-azo-4-anthrol: 503 in EtOH; K salt, 588 in EtOH (595).
- $C_{20}H_{15}N_3O_3$.—*p*-Nitrobenzeneazoanthrol: 460 in EtOH (595).
- p*-Nitrobenzene-1-azo-4-anthrol: 482 in EtOH; K salt, 650 in EtOH (595).
- 3'-Nitro-4-hydroxyazonaphthalene: 557 in H_2O (471).
- $C_{20}H_{14}N_2O$.—Benzeneazoanthrol: 466 in EtOH; K salt, 580 in EtOH (595).
- Benzene-1-azo-4-anthrol: 499 in EtOH; K salt, 549 in EtOH (595).
- α -Naphthaleneazo- β -naphthol (Autol Red RL, C. I. 82): 628, 585.8 in H_2SO_4 (190).
- β -Naphthaleneazo- β -naphthol: 483 in EtOH (85).
- β , β' -Azoxynaphthalene: 337, 282, 266 in EtOH (?) [550 after exposure to light] (85).
- $C_{20}H_{14}N_2O_4S$.—*p*-Sulfobenzene-1-azo-4-anthrol: 503 in EtOH; K salt, 571 in EtOH (595).
- α -Naphthaleneazo- α -naphthol-2-sulfonic acid: Na salt (424q).
- β -Naphthaleneazo- α -naphthol-2-sulfonic acid: Na salt (424q).
- 4-Sulfo- α -naphthaleneazo- α -naphthol (Na salt, C. I. 175): (231).
- 4-Sulfo- α -naphthaleneazo- β -naphthol (Na salt, Fast Red A.S., C. I. 176): 500 in H_2O (concd.); 505 (dil.) (269); cf. (231, 390, 391, 516).
- $C_{20}H_{14}N_2O_7S_2$.— α -Naphthaleneazo- β -naphthol-3, 6-disulfonic acid (Na salt, Bordeaux B, C. I. 88): 510 in H_2O (concd.); 515 (dil.) (269); cf. (421q, 516q, 588).
- α -Naphthaleneazo- β -naphthol-6, 8-disulfonic acid (Na salt, Crystal Scarlet, C. I. 89): 508, 329.5 in H_2O (391q); cf. (388q, 518q).
- 4-Sulfo- α -naphthaleneazo- α -naphthol-2-sulfonic acid: Na salt (424q).
- 4-Sulfo- α -naphthaleneazo- α -naphthol-4-sulfonic acid (Na salt, C. I. 179): "Azorubin," infra-red abs. (511); Pontacyl Ruby G, 505 in H_2O (concd.); 512 (dil.) (269); Chromotrope FB, 555.9, 519.5 in dil. HOAc; 569.5 in H_2SO_4 ; Chrome Lake, 620.7, 575.7, 537.5 in 90% HOAc + HCl; 614.7, 568.2, 530.3 in H_2SO_4 (190).

$C_{20}H_{14}N_2O_8S_2$.— α -Naphthaleneazo-1, 8-dihydroxynaphthalene-3, 6-disulfonic acid (Na salt, C. I. 90): 533 in 0.1*N* HCl; 519 in 0.1*N* NaOH; 535 in H_2O (pH 6.75) (119).

$C_{20}H_{14}N_2O_{10}S_3$.— α -Naphthaleneazo- α -naphthol-3, 6, 8-trisulfonic acid: Na salt, 534 in 0.1*N* HCl; 514 in 0.1*N* NaOH; 535 in pH 6.75 soln. (119).

4-Sulfo- α -naphthaleneazo- β -naphthol-3, 6-disulfonic acid (Na salt, Amaranth, C. I. 184): 522, 331 in H_2O (1799); cf. (4229).

4-Sulfo- α -naphthaleneazo- β -naphthol-6, 8-disulfonic acid (Na salt, C. I. 185): Cochineal Red A, 515, 500 on wool (522).

$C_{20}H_{15}N_3$.— α -naphthaleneazo- α -naphthylamine: (2319).

β -Naphthaleneazo- β -naphthylamine: (2319).

$C_{20}H_{15}N_3O_4S$.—4-Sulfo-1-naphthylamineazo- β -naphthol: Na salt, 500 in H_2O ; 629, 587.5 in H_2SO_4 (123).

5-Sulfo-1-naphthylamineazo- β -naphthol: Na salt, 499 in H_2O ; 608.5, 568 in H_2SO_4 (123).

6-Sulfo-1-naphthylamineazo- β -naphthol: Na salt, 499 in H_2O ; 607.5, 568.5 in H_2SO_4 (123).

7-Sulfo-1-naphthylamineazo- β -naphthol: Na salt, 500 in H_2O ; 572 in H_2SO_4 (123).

1-Sulfo-2-naphthylamineazo- β -naphthol: Na salt, 505.5 in H_2O ; 589.5, 552.5 in H_2SO_4 (123).

5-Sulfo-2-naphthylamineazo- β -naphthol: Na salt, 492.5 in H_2O ; 576, 541.5 in H_2SO_4 (123).

6-Sulfo-2-naphthylamineazo- β -naphthol: Na salt, 494 in H_2O ; 579.5, 543.5 in H_2SO_4 (123).

7-Sulfo-2-naphthylamineazo- β -naphthol: Na salt, 493 in H_2O ; 580, 543 in H_2SO_4 (123).

8-Sulfo-2-naphthylamineazo- β -naphthol: Na salt, 494.5 in H_2O ; 581, 544.5 in H_2SO_4 (123).

$C_{20}H_{15}N_3O_7S_2$.— α -Naphthaleneazo-8-amino- α -naphthol-3, 6-disulfonic acid: Na salt, 544 in 0.1*N* HCl; 545 in 0.1*N* NaOH; 548 in pH 6.75 soln. (11).

3, 6-Disulfo-1-naphthylamineazo- β -naphthol: Na salt, 498.5 in H_2O ; 604.5, 568 in H_2SO_4 (123).

3, 8-Disulfo-1-naphthylamineazo- β -naphthol: Na salt, 492 in H_2O ; 578.5, 542 in H_2SO_4 (123).

4, 7-Disulfo-1-naphthylamineazo- β -naphthol: Na salt, 498.5 in H_2O ; 617, 575 in H_2SO_4 (123).

4, 8-Disulfo-1-naphthylamineazo- β -naphthol: Na salt, 491 in H_2O ; 540 in H_2SO_4 (123).

3, 6-Disulfo-2-naphthylamineazo- β -naphthol: Na salt, 493.5 in H_2O (123).

4, 7-Disulfo-2-naphthylamineazo- β -naphthol: Na salt, 495.5 in H_2O ; 582, 542.5 in H_2SO_4 (123).

4, 8-Disulfo-2-naphthylamineazo- β -naphthol: Na salt, 492 in H_2O ; 581.5, 544.5 in H_2SO_4 (123).

5, 7-Disulfo-2-naphthylamineazo- β -naphthol: Na salt, 490.5 in H_2O ; 580, 543 in H_2SO_4 (123).

6, 8-Disulfo-2-naphthylamineazo- β -naphthol: Na salt, 494.5 in H_2O ; 583.5, 546 in H_2SO_4 (123).

$C_{20}H_{15}N_3O_{10}S_3$.—5-Sulfo-1-naphthylamineazo- β -naphthol-3, 6-disulfonic acid: Na salt, 594.5, 555 in H_2SO_4 (123).

6-Sulfo-1-naphthylamineazo- β -naphthol-3, 6-disulfonic acid: Na salt, 572, 537.5 in H_2SO_4 (123).

$C_{20}H_{15}N_3O_{13}S_4$.—3, 6-Disulfo-2-naphthylamineazo- β -naphthol-3, 6-disulfonic acid: Na salt, 495 in H_2O ; 583, 547 in H_2SO_4 (123).

$C_{20}H_{16}N_2O_2$.—*p*-Benzoylbenzeneazo-*p*-cresol: 327 in EtOH; 513, 341 in NaOH (258); cf. (618).

$C_{20}H_{16}N_4O_5S$.—4-Sulfo-1, 5-diamino-2-naphtholazo- α -naphthol: Na salt, 521.5 in alk. soln.; 518 in acid soln. (123).

$C_{20}H_{16}N_4O_{11}S_3$.—3-Sulfo-2, 5-diamino-1-naphtholazo- β -naphthol-3, 6-disulfonic acid: Na salt, 496.5 in H_2SO_4 (123).

$C_{20}H_{17}N_3O$.—*p*-Methoxybenzylideneaminoazobenzene: 327 in EtOH; 513, 341 in NaOH (521).

$C_{20}H_{18}N_4O_9S_2$.—*p*-Acetylaminobenzeneazo-8-acetyl amino- α -naphthol-3, 6-disulfonic acid (Na salt, C. I. 57): Pontacyl Carmine 6B, 514 in H_2O (concd.); 525 (dil.) (269).

$C_{20}H_{20}N_2O$.—*p*-Cymeneazo- β -naphthol: 532 in H_2SO_4 (677).

$C_{20}H_{20}N_2O_3S$.—*p*-Cymeneazo- α -naphthalene-4-sulfonic acid: Na salt, 460 in H_2O (677).

$C_{20}H_{20}N_2O_4S$.—*o*-Methyl-*m*-isopropyl-*p*-sulfo benzeneazo- β -naphthol: Na salt, 495 in H_2O (271).

$C_{20}H_{20}N_2O_7S_2$.—*o*-Methyl-*m*-isopropylbenzeneazo- β -naphthol-6, 8-disulfonic acid: Na salt, 492 in H_2O (271).

$C_{20}H_{20}N_2O_8S_2$.—*o*-Methyl-*m*-isopropylbenzeneazo-1, 8-dihydroxynaphthalene-3, 6-disulfonic acid: Na salt, 520 in H_2O (271).

$C_{20}H_{20}N_2O_{10}S_3$.—*o*-Methyl-*m*-isopropyl-*p*-sulfo benzeneazo- β -naphthol-3, 6-disulfonic acid: Na salt, 498 in H_2O (677). (The 6, 8-disulfo isomer in H_2O , 485 (677).)

$C_{20}H_{20}N_2O_{11}S_3$.—*o*-Methyl-*m*-isopropyl-*p*-sulfo benzeneazo-1, 8-dihydroxynaphthalene-3, 6-disulfonic acid: Na salt, 525 in H_2O (271).

$C_{20}H_{21}N_3$.—*p*-Cymeneazo- β -naphthylamine: 570 in H_2SO_4 (677).

$C_{20}H_{26}N_2$.—Azocymene: 465 in H_2SO_4 (677).

$C_{21}H_{13}N_3O_5$.—*p*-Nitronaphthalene-1-azo-4-naphthol-3-carboxylic acid: 470 in EtOH; K salt, 606 in EtOH (595).

$C_{22}H_{17}N_3O_3S$.—4-Diphenylazo- α -naphthylamine-4-sulfonic acid: 575 in dil. HCl (468).

$C_{22}H_{18}N_4O_5S$.—8-Sulfo-4-amino-1-phenylnaphthylamineazo-resorcinol: 561.5 with excess H_2SO_4 (123).

$C_{22}H_{19}N_3O_7S_2$.—3, 6-Disulfo-8-hydroxy- α -naphthaleneazoethyl- α -naphthylamine (Na salt, C. I. 307): Pontacyl Sulfon Violet R, 530 in H_2O (concd.); 550 (dil.) (269).

$C_{22}H_{20}N_2O_2$.—*p*-Benzoylbenzeneazo-*p*-cresetole: 326 in EtOH (618).

$C_{23}H_{16}N_2O_2$.—*p*-Benzoylbenzeneazo- α -naphthol: 461, 330 in EtOH; 535, 300 in NaOH (258).

p-Benzoylbenzeneazo- β -naphthol: 486, 320 in EtOH; 513, 283 in NaOH (258).

$C_{23}H_{16}N_4O_4$.—*p*-Nitrobenzeneazo- β -hydroxynaphthoic acid anilide (Fast Red GG): 570 in H_2SO_4 (677).

$C_{23}H_{22}N_4O_3$.—Phenyl-(*p*-dimethylaminobenzeneazobenzoyl-amino)-acetic acid: 461, 375 (306), 274 in EtOH (abs. of *d*, *l*, and *dl* forms identical) (649).

$C_{24}H_{16}ClN_3O_7S_3$.—Benzenylaminothiocresolazo-8-chloro- α -naphthol-3, 6-disulfonic acid (Na salt, C. I. 128): Diamine Rose BD on cotton and silk (627).

$C_{25}H_{19}N_3O_4$.— β -Naphthol deriv. of diazotized phenyl-(*p*-aminobenzoylamino)-acetic acid: 486, (381), 314, (271) in H_2O ; 516, 443 with excess alkali; 553, 522 with excess acid (abs. of *d*, *l* and *dl* forms identical) (639).

$C_{26}H_{17}N_3O_6$.—*p*-Nitrobenzeneazophenolphthalein: alkali salt, 568 in Me_2CO ; 508 in EtOH; 495 in H_2O (643); cf. (501).

$C_{26}H_{21}N_5O_5S_2$.—3-Sulfo-2, 5-diamino- α -naphtholazophenyl- β -naphthylamine-5-hydroxy-7-sulfonic acid: 493.8 in dil. H_2SO_4 (123).

$C_{27}H_{20}N_4O_9S_2$.—8-Benzoylamino-2-amino-3, 5-disulfo- α -naphtholazo- β -naphthol: 525, 493 in H_2SO_4 (123).

Aminobenzoyl-H-acid-azo- β -naphthol: 608, 578 in H_2SO_4 (123).

Azo dyes derived from substituted pyrroles: (33, 378, 399, 408, 409).

p-Nitrobenzeneazocephaline: 610 in alk. Me_2CO ; 550 in alk. EtOH; 525 in alk. H_2O (502).

p-Nitrobenzeneazoemetamine: 627.5 in alk. Me_2CO ; 590 in alk. EtOH; 570 in alk. H_2O (502).

TABLE 2.—POLYAZO DYES

$C_{18}H_{13}N_5O_3$.—*p*-Nitrobenzeneazobenzeneazophenol: 395 in EtOH; Na salt, 546 in EtOH (521).

$C_{18}H_{14}N_4O$.—Benzeneazobenzeneazophenol: 435 (111); 497 in alk. H_2O (463).

$C_{18}H_{14}N_4O_2$.—Phenolazobenzeneazophenol: disodium salt, 515 in H_2O (463).

$C_{18}H_{18}N_8$.—Benzene-*m*-disazo-*bis*-*m*-phenylenediamine (hydrochloride, Bismarck Brown Y, C. I. 331): infra-red abs. (296); 460 on cotton (627); cf. (231).

$C_{20}H_{19}N_5$.—Benzeneazobenzeneazodimethylaniline: 509 (111).

$C_{22}H_{16}N_7O_{11}S_2$.—2-*p*-Nitrobenzeneazo-1-amino-8-naphthol-3, 6-disulfo-7-azo-*p*-nitrobenzene: Na salt, 612 in H_2O (609).

$C_{22}H_{16}N_4O$.—Benzeneazobenzeneazo- α -naphthol: 655, 625 in H_2SO_4 (196).

Benzeneazobenzeneazo- β -naphthol (Sudan III, C. I. 248): 640.9, 589.8 in H_2SO_4 (190); cf. (196).

$C_{22}H_{16}N_4O_3S$.—*p*-Sulfobenzeneazobenzeneazo- α -naphthalene: Na salt, 507 in H_2O ; 516 in 0.02*N* HCl; 663 in H_2SO_4 (436).

$C_{22}H_{16}N_4O_4S$.—Benzeneazobenzeneazo- α -naphthol-4-sulfonic acid (Na salt, C. I. 249): 627, 575 in H_2SO_4 (196).

Benzeneazobenzeneazo- β -naphthol-6-sulfonic acid: 610, 580 in H_2SO_4 (196).

Benzeneazobenzeneazo- β -naphthol-8-sulfonic acid: 598, 572 in H_2SO_4 (196).

$C_{22}H_{16}N_4O_6S_2$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo- α -naphthalene: Na salt, 524 in H_2O ; 542 in alk. H_2O ; 519 in 0.02*N* HCl; 643 in H_2SO_4 (436).

p-Sulfobenzeneazobenzeneazo- α -naphthalene-7-sulfonic acid: Na salt, 532 in H_2O (520 with alkali); 496 in 0.02*N* HCl; 657 in H_2SO_4 (436).

$C_{22}H_{16}N_4O_7S_2$.—Benzeneazobenzeneazo- α -naphthol-4, 8-disulfonic acid (Na salt, C. I. 251): 630, 575 in H_2SO_4 (196).

Benzeneazobenzeneazo- β -naphthol-3, 6-disulfonic acid (Na salt, C. I. 253): 616, 573 in H_2SO_4 (196).

Benzeneazobenzeneazo- β -naphthol-6, 8-disulfonic acid (Na salt, C. I. 252): 592, 550 in H_2SO_4 (196). Brilliant Croceine M, 545 on silk (627).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo- β -naphthol (Na salt, Biebrich Searlet, C. I. 280): (231).

$C_{22}H_{16}N_4O_9S_3$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo- α -naphthalene-7-sulfonic acid: Na salt, 539 in H_2O ; 530 in 0.02*N* HCl; 638 in H_2SO_4 (436).

$C_{22}H_{16}N_4O_{10}S_3$.—Benzeneazobenzeneazo- α -naphthol-3, 6, 8-trisulfonic acid: 620, 573 in H_2SO_4 (196).

Benzeneazobenzeneazo- β -naphthol-3, 6, 8-trisulfonic acid: 600, 555 in H_2SO_4 (196).

p-Sulfobenzeneazobenzeneazo- α -naphthol-4, 8-disulfonic acid: 642 in H_2SO_4 (196).

p-Sulfobenzeneazobenzeneazo- β -naphthol-3, 6-disulfonic acid: 607, 575 in H_2SO_4 (196).

p-Sulfobenzeneazobenzeneazo- β -naphthol-6, 8-disulfonic acid: 587 in H_2SO_4 (196).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo- α -naphthol-4-sulfonic acid: 688, 596 in H_2SO_4 (196).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo- β -naphthol-8-sulfonic acid: 620 in H_2SO_4 (196).

$C_{22}H_{16}N_4O_{13}S_4$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo- α -naphthol-4, 8-disulfonic acid: 631, 584 in H_2SO_4 (196).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo- β -naphthol-3, 6-disulfonic acid: 630, 575 in H_2SO_4 (196).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo- β -naphthol-6, 8-disulfonic acid: 589 in H_2SO_4 (196).

$C_{22}H_{16}N_4O_{16}S_5$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo- α -naphthol-3, 6, 8-trisulfonic acid: 629, 582 in H_2SO_4 (196).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo- β -naphthol-3, 6, 8-trisulfonic acid: 607, 580 in H_2SO_4 (196).

$C_{22}H_{16}N_6O_9S_2$.—*p*-Nitrobenzeneazo-3, 6-disulfo-*S*-amino- α -naphtholazobenzene (Na salt, C. I. 246): Agalma Black 10B, 620 in H_2O (129); cf. (609); 600 in H_2O (coned.); 620 (dil.) (269).

$C_{22}H_{24}N_6$.—4, 4'-Benzenedisazodimethylaniline: (570), 544, 510 (473).

$C_{24}H_{18}N_4O_2$.—Diphenyldisazo-*bis*-phenol: monosodium salt, 496 (NaHCO₃); disodium salt, 370 (NaOH) (463).

5, 5'-*Bis*-benzeneazo-2, 2'-diphenol: 344 in EtOH (?) (544).

$C_{24}H_{18}N_4O_8S_2$.—Diphenyldisazo-*bis*-*p*-sulfophenol: 475 in alk. H_2O (468).

$C_{24}H_{18}N_6O$.—Benzeneazobenzeneazobenzeneazophenol: 436 (111).

$C_{24}H_{20}N_4O$.—*o*-Tolueneazo-*o*-tolueneazo- β -naphthol (Sudan IV, C. I. 258): 657.4, 605.5 in H_2SO_4 (190); cf. (516).

$C_{24}H_{20}N_4O_4S$.—*o*-Tolueneazo-*o*-tolueneazo- α -naphthol-4-sulfonic acid: 629, 589 in H_2SO_4 (196).

o-Tolueneazo-*o*-tolueneazo- β -naphthol-6-sulfonic acid: 630, 589 in H_2SO_4 (196).

o-Tolueneazo-*o*-tolueneazo- β -naphthol-8-sulfonic acid: 620, 580 in H_2SO_4 (196).

$C_{24}H_{20}N_4O_5S$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol: Na salt, 506 in H_2O ; 503 in 0.02*N* HCl; 592 in 0.02*N* NaOH; 530 in 85% EtOH; 587 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol: Na salt, 506 in H_2O ; 502 in 0.02*N* HCl; 497 in 0.02*N* NaOH; (566), 540 in 85% EtOH; 661, 597 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol: Na salt, 513 in H_2O ; 512 in 0.02*N* HCl; 596 in 0.02*N* NaOH; 530 in 85% EtOH; 631, 586 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol: Na salt, 515 in H_2O ; 511 in 0.02*N* HCl; 507 in 0.02*N* NaOH; (566), 545 in 85% EtOH; 633, 610 in 80% HCOOH (436).

$C_{24}H_{20}N_4O_7S_2$.—*o*-Tolueneazo-*o*-tolueneazo- α -naphthol-4, 8-disulfonic acid: 630, 575 in H_2SO_4 (196).

o-Tolueneazo-*o*-tolueneazo- β -naphthol-3, 6-disulfonic acid: 635, 580 in H_2SO_4 (196).

p-Sulfo-*o*-tolueneazo-*o*-tolueneazo- α -naphthol-4-sulfonic acid: 647, 589 in H_2SO_4 (196).

p-Sulfo-*o*-tolueneazo-*o*-tolueneazo- β -naphthol-6-sulfonic acid: 650, 589 in H_2SO_4 (196).

p-Sulfo-*o*-tolueneazo-*o*-tolueneazo- β -naphthol-8-sulfonic acid: 630, 585 in H_2SO_4 (196).

o-Tolueneazo-*o*-tolueneazo- β -naphthol-6,8-disulfonic acid: 675, 580 in H_2SO_4 (196).

$C_{24}H_{20}N_4O_8S_2$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-4-sulfonic acid: Na salt, 591, 531 in H_2O ; 604, 524 in 0.02*N* HCl; 555 in 0.02*N* NaOH; 583, 538 in 85% EtOH; 675, 585, 542 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-4-sulfonic acid: Na salt, 594, 533 in H_2O ; 601, 525 in 0.02*N* HCl; 586, 549 in 0.02*N* NaOH; 586, 549 in 85% EtOH; 676, 588, 547 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-5-sulfonic acid: Na salt, 608, 545 in H_2O ; 616, 537 in 0.02*N* HCl; 587, 546 in 85% EtOH; 556 in 0.02*N* NaOH; 674, 602, 554 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-5-sulfonic acid: Na salt, 604, 546 in H_2O ; 612, 538 in 0.02*N* HCl; 598, 560 in 0.02*N* NaOH; 585, 546 in 85% EtOH; 677, 606, (553) in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-7-sulfonic acid: Na salt, 522 in H_2O ; 518 in 0.02*N* HCl; 576 in 0.02*N* NaOH; 523 in 85% EtOH; 629, 586 in 80% HCOOH (436).

$C_{24}H_{20}N_4O_8S_2$.—*p*-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-7-sulfonic acid: Na salt, 522 in H_2O ; 518 in 0.02*N* HCl; 578 in 0.02*N* NaOH; 531 in 85% EtOH; 636, 587 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-8-sulfonic acid: Na salt, 528 in H_2O ; 523 in 0.02*N* HCl; 635 in 0.02*N* NaOH; 626, 582 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-8-sulfonic acid: Na salt, 535 in H_2O ; 528 in 0.02*N* HCl; 635 in 0.02*N* NaOH; 631, 586 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-6-sulfonic acid: Na salt, 625 in H_2O ; 617 in 0.02*N* HCl; 523 in 0.02*N* NaOH; 573, 541 in 85% EtOH; 660, 563 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-6-sulfonic acid: Na salt, 525 in H_2O ; 522 in 0.02*N* HCl; 528 in 0.02*N* NaOH; 573, 544 in 85% EtOH; 666, 592, 564 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-8-sulfonic acid: Na salt, 535 in H_2O ; 533 in 0.02*N* HCl; 526 in 0.02*N* NaOH; 558, 533 in 85% EtOH; 651, 598 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-8-sulfonic acid: Na salt, 539 in H_2O ; 535 in 0.02*N* HCl; 527 in 0.02*N* NaOH; 563, 537 in 85% EtOH; 656, 609 in 80% HCOOH (436).

$C_{24}H_{20}N_4O_{10}S_3$.—*o*-Tolueneazo-*o*-tolueneazo- α -naphthol-3, 6, 8-trisulfonic acid: 640, 592 in H_2SO_4 (196).

p-Sulfo-*o*-tolueneazo-*o*-tolueneazo- α -naphthol-4, 8-disulfonic acid: 630, 575 in H_2SO_4 (196).

p-Sulfo-*o*-tolueneazo-*o*-tolueneazo- β -naphthol-3, 6-disulfonic acid: 630, 580 in H_2SO_4 (196).

$C_{24}H_{20}N_4O_{11}S_3$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 6-disulfonic acid: Na salt, 585, 549 in H_2O ; 550 in 0.02*N* HCl; 532 in 0.02*N* NaOH; 573, 539 in 85% EtOH; 664, 601 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 6-disulfonic acid: Na salt, 580, 551 in H_2O ; 586, 548 in 0.02*N* HCl; 554 in 0.02*N* NaOH; 579, 538 in 85% EtOH; 667, 602 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 8-disulfonic acid: Na salt, 574, 551 in H_2O ; 545 in 0.02*N* HCl; 555 in 0.02*N* NaOH; 569, 539 in 85% EtOH; 657, 606 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 8-disulfonic acid: Na salt, 573, 554 in H_2O ; 552 in 0.02*N* HCl; 553 in 0.02*N* NaOH; 574, 542 in 85% EtOH; 663, 612 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-3, 6-disulfonic acid: Na salt, 588, 543 in H_2O ; 595, 542 in 0.02*N* HCl; 548 in 0.02*N* NaOH; 573, 549 in 85% EtOH; 664, 553 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-3, 6-disulfonic acid: Na salt, 590, 543 in H_2O ; 596, 541 in 0.02*N* HCl; 549 in 0.02*N* NaOH; 573, 550 in 85% EtOH; 669, 594, 558 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-6, 8-disulfonic acid: Na salt, 577, 537 in H_2O ; 582, 534 in 0.02*N* HCl; 575, 539 in 0.02*N* NaOH; 567, 537 in 85% EtOH; 654 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-6, 8-disulfonic acid: Na salt, 574, 540 in H_2O ; 597, 537 in 0.02*N* HCl; 575, 541 in 0.02*N* NaOH; 566, 537 in 85% EtOH; 658, 580 in 80% HCOOH (436).

2, 4-Disulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-4-sulfonic acid: Na salt, 594, 547 in H_2O ; 600, 544 in 0.02*N* HCl; (598), 564 in 0.02*N* NaOH; 584, 542 in 85% EtOH; 687, 588, 547 in 80% HCOOH (436).

$C_{24}H_{20}N_4O_{12}S_3$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo-1, 8-dihydroxynaphthalene-3, 6-disulfonic acid: Na salt, 602, 560 in

H_2O ; 610, 564 in 0.02*N* HCl; 596 in 0.02*N* NaOH; 603, 560 in 85% EtOH; 685, 606, 561 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo-1, 8-dihydroxynaphthalene-3, 6-disulfonic acid: Na salt, 600, 562 in H_2O ; 602, 561 in 0.02*N* HCl; 599 in 0.02*N* NaOH; 604, 559 in 85% EtOH; 688, 614, 567 in 80% HCOOH (436).

$C_{24}H_{20}N_4O_{13}S_4$.—*p*-Sulfo-*o*-tolueneazo-*o*-tolueneazo- α -naphthol-3, 6, 8-trisulfonic acid: 650 in H_2SO_4 (196).

p-Sulfo-*o*-tolueneazo-*o*-tolueneazo- β -naphthol-3, 6, 8-trisulfonic acid: 630, 585 in H_2SO_4 (196).

$C_{24}H_{20}N_4O_{14}S_4$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 6, 8-trisulfonic acid: Na salt (580), 558 in H_2O ; (582), 561 in 0.02*N* HCl; 570 in 0.02*N* NaOH; 581 in 85% EtOH; 663, 608 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 6, 8-trisulfonic acid: Na salt, 566 in H_2O ; (583), 559 in 0.02*N* HCl; 579, 559 in 0.02*N* NaOH; 584, 545 in 85% EtOH; 669, 613 in 80% HCOOH (436).

m-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-3, 6, 8-trisulfonic acid: Na salt, 593, 545 in H_2O ; 594, 542 in 0.02*N* HCl; 547 in 0.02*N* NaOH; 576, 548 in 85% EtOH; 665, 557 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo- β -naphthol-3, 6, 8-trisulfonic acid: Na salt, 592, 545 in H_2O ; 598, 543 in 0.02*N* HCl; 548 in 0.02*N* NaOH; 578, 550 in 85% EtOH; 673 in 80% HCOOH (436).

2, 4-Disulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 8-disulfonic acid: Na salt, 573, 558 in H_2O ; 576, 552 in 0.02*N* HCl; 565 in 0.02*N* NaOH; 575, 537 in 85% EtOH; 674 in 80% HCOOH (436).

$C_{24}H_{20}N_4O_{15}S_4$.—2, 4-Disulfobenzeneazo-*p*-methylanisoleazo-1, 8-dihydroxynaphthalene-3, 6-disulfonic acid: Na salt, 603, 571 in H_2O ; 598, 564 in 0.02*N* HCl; 602 in 0.02*N* NaOH; 606, 563 in 85% EtOH; 692, 613 in 80% HCOOH (436).

$C_{24}H_{20}N_4O_{17}S_5$.—2, 4-Disulfobenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 6, 8-trisulfonic acid: Ba salt, 577, 566 in H_2O ; 565 in 0.02*N* HCl; 576 in 0.02*N* NaOH; 583, 547 in 85% EtOH; 678, 618 in 80% HCOOH (436).

$C_{24}H_{21}N_5O_8S_2$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, 592, 533 in H_2O ; 525 in 0.02*N* HCl; 587, 532 in 0.02*N* NaOH; 558, 534 in 85% EtOH; 657 in 80% HCOOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, 585, 536 in H_2O ; 498 in 0.02*N* HCl; 591, 535 in 0.02*N* NaOH; 554, 533 in 80% EtOH; 662, 600, 559 in 80% HCOOH (436).

$C_{24}H_{21}N_5O_{11}S_3$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo-8-amino- α -naphthol-3, 6-disulfonic acid: Na salt, 593 in H_2O ; 605-571 in 0.02*N* HCl; 587 in 0.02*N* NaOH; 607, 563 in 85% EtOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo-8-amino- α -naphthol-3, 6-disulfonic acid: Na salt, 603, 575 in H_2O ; 603, 569 in 0.02*N* HCl; 593 in 0.02*N* NaOH; 607, 567 in 85% EtOH (436).

2, 4-Disulfobenzeneazo-*p*-methylanisoleazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, 575, 550 in H_2O ; 591, 542 in 0.02*N* NaOH; 565, 539 in 85% EtOH; 676 in 80% HCOOH (436).

$C_{24}H_{21}N_5O_{14}S_4$.—2, 4-Disulfobenzeneazo-*p*-methylanisoleazo-8-amino- α -naphthol-3, 6-disulfonic acid: Na salt, 619, 590 in H_2O ; 559, 573 in 0.02*N* HCl; 605 in 0.02*N* NaOH; 612, 573 in 85% EtOH (436).

$C_{24}H_{30}N_4O_5$.—*p*-Nitrobenzeneazocapsaicin: alkali salt, 593 in Me_2CO ; 550 in EtOH; 510 in H_2O (643).

$C_{25}H_{22}N_4O_8S_2$.—4-Sulfo-2-methylbenzeneazo-*p*-methylanisoleazo- α -naphthol-4-sulfonic acid: Na salt, (593), 530 in H_2O ; (604), 524 in 0.02*N* HCl; 552 in 0.02*N* NaOH; 583, 542 in 85% EtOH (436).

$C_{25}H_{22}N_4O_{11}S_3$.—4-Sulfo-2-methylbenzeneazo-*p*-methylanisoleazo- α -naphthol-3, 8-disulfonic acid: Na salt, 576, 551 in H_2O ; 545 in 0.02*N* HCl; 552 in 0.02*N* NaOH; 572, 538 in 85% EtOH; 667, 578, 552 in 80% HCOOH (436).

$C_{26}H_{22}N_4O_{12}S_3$.—4-Sulfo-2-methylbenzeneazo-*p*-methylanisoleazo-1, 8-dihydroxynaphthalene-3, 6-disulfonic acid: Na salt, 599, 563 in H_2O ; 604, 562 in 0.02*N* HCl; 597 in 0.02*N* NaOH; 602, 561 in 85% EtOH; 554, 513 in 80% HCOOH (436).

$C_{26}H_{23}N_5O_8S_2$.—4-Sulfo-2-methylbenzeneazo-*p*-methylanisoleazo-6-amino- α -naphthol-3-sulfonic acid: Na salt (592), 533 in H_2O ; 510 in 0.02*N* HCl; 588, 533 in 0.02*N* NaOH; 558, 533 in 85% EtOH (436).

$C_{26}H_{23}N_5O_{11}S_3$.—4-Sulfo-2-methylbenzeneazo-*p*-methylanisoleazo-8-amino- α -naphthol-3, 6-disulfonic acid: Na salt, 602, 582 in H_2O ; 607, 568 in 0.02*N* HCl; 587 in 0.02*N* NaOH; 607, 567 in 85% EtOH (436).

$C_{26}H_{22}N_4O_2$.—5, 5'-*Bis-p*-tolueneazo-2, 2'-diphenol: 350 in EtOH (544).

$C_{26}H_{23}N_7$.—Benzeneazobenzeneazobenzeneazodimethylaniline: 513 (111).

$C_{27}H_{20}N_6O_7$.—Diphenylurea-*p*, *p'*-disazo-*bis*-salicylic acid (Na salt, C. I. 346): Cotton Yellow G (600).

$C_{28}H_{22}N_4O_{11}S_3$.—6-Sulfo- β -naphthaleneazo-*p*-methylanisoleazo- β -naphthol-3, 6-disulfonic acid: Na salt, 543 in H_2O ; 539 in 0.02*N* HCl; 537 in 0.02*N* NaOH; 576, 546 in 85% EtOH; 692 in 80% HCOOH (436).

7-Sulfo- α -naphthaleneazo-*p*-methylanisoleazo- β -naphthol-3, 6-disulfonic acid: Na salt, 552 in H_2O ; 548 in 0.02*N* HCl; 553 in 0.02*N* NaOH; 580, 556 in 85% EtOH (436).

$C_{28}H_{22}N_4O_{14}S_4$.—3, 6-Disulfo- α -naphthaleneazo-*p*-methylanisoleazo- β -naphthol-3, 6-disulfonic acid: Na salt, 553 in H_2O ; (602), 553 in 0.02*N* HCl; (587), 551 in 0.02*N* NaOH; 586, 557 in EtOH (436).

3, 6-Disulfo- β -naphthaleneazo-*p*-methylanisoleazo- β -naphthol-3, 6-disulfonic acid: Na salt, 552 in H_2O ; 558 in 0.02*N* HCl; 540 in 0.02*N* NaOH; 576, 500 in 85% EtOH; 705 in 80% HCOOH (436).

$C_{28}H_{22}N_4O_{17}S_5$.—3, 6, 8-Trisulfo- β -naphthaleneazo-*p*-methylanisoleazo- β -naphthol-3, 6-disulfonic acid: Na salt, 573, 556 in H_2O ; 584, 556 in 0.02*N* HCl; 548 in 0.02*N* NaOH; 580, 555 in 85% EtOH; 707 in 80% HCOOH (436).

$C_{28}H_{23}N_5O_8S_2$.—6-Sulfo- β -naphthaleneazo-*p*-methylanisoleazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, 592 in H_2O ; 530 in 0.02*N* HCl; (598), 547 in 0.02*N* NaOH; 568, 546 in 85% EtOH (436).

7-Sulfo- α -naphthaleneazo-*p*-methylanisoleazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, 543 in H_2O ; 538 in 0.02*N* HCl; 543 in 0.02*N* NaOH; 551 in 85% EtOH (436).

$C_{28}H_{23}N_5O_{11}S_3$.—3, 6-Disulfo- α -naphthaleneazo-*p*-methylanisoleazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, 543 in H_2O ; 538 in 0.02*N* HCl; 543 in 0.02*N* NaOH; 551 in 85% EtOH (436).

3, 6-Disulfo- β -naphthaleneazo-*p*-methylanisoleazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, (582), 548 in H_2O ; 546 in 0.02*N* HCl; 544 in 0.02*N* NaOH; 572, 546 in 85% EtOH (436).

$C_{29}H_{21}N_6O_7S$.—2-Amino-6-sulfo- α -naphtholazodiphenylazosalicylic acid (Na salt, C. I. 419): Diamine Fast Red F, 532.5 on silk (627).

$C_{29}H_{23}N_6O_4S$.—4-Sulfo- α -naphthylamineazodiphenylazocresol: (Na salt, C. I. 374): Erie Orange 2R, 483 in H_2O ; 490 in 0.1*N* NaOH; 480 in EtOH (677).

$C_{30}H_{22}N_8O$.—Benzeneazobenzeneazobenzeneazobenzeneazophenol: 436 (111).

$C_{30}H_{25}N_6O_8S_2$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, (603), 544 in H_2O ;

534 in 0.02*N* HCl; 553 in 0.02*N* NaOH; 572, 546 in 85% EtOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, 545 in H_2O ; 535 in 0.02*N* HCl; (590), 552 in 0.02*N* NaOH; 574, 548 in 85% EtOH (436).

$C_{30}H_{25}N_6O_{11}S_3$.—2, 4-Disulfobenzeneazo-*p*-methylanisoleazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, 556 in H_2O ; 567 in 0.02*N* HCl; 559 in 0.02*N* NaOH; 579, 550 in 85% EtOH (436).

$C_{31}H_{25}N_6O_9S_2$.—*m*-Sulfobenzeneazo-*p*-methylanisoleazo-6-benzoylamino- α -naphthol-3-sulfonic acid: Na salt, 604, 520 in H_2O ; (614), 518 in 0.02*N* HCl; 536 in 0.02*N* NaOH; 568, 537 in 85% EtOH (436).

p-Sulfobenzeneazo-*p*-methylanisoleazo-6-benzoylamino- α -naphthol-3-sulfonic acid: Na salt, (603), 536 in H_2O ; (610), 525 in 0.02*N* HCl; 540 in 0.02*N* NaOH; 570, 538 in 85% EtOH (436).

$C_{31}H_{25}N_6O_{12}S_3$.—2, 4-Disulfobenzeneazo-*p*-methylanisoleazo-6-benzoylamino- α -naphthol-3-sulfonic acid: Na salt, (603), 539 in H_2O ; 532 in 0.02*N* HCl; (596), 544 in 0.02*N* NaOH; 575, 544 in 85% EtOH (436).

$C_{31}H_{27}N_6O_8S_2$.—4-Sulfo-2-methylbenzeneazo-*p*-methylanisoleazo-6-phenylamino- α -naphtholsulfonic acid: Na salt, (605), 542 in H_2O ; 532 in 0.02*N* HCl; 548 in 0.02*N* NaOH; 571, 546 in 85% EtOH (436).

$C_{32}H_{22}N_4O_2$.—Diphenyldisazo-*bis*- β -naphthol (C. I. 381): 640.6, 595.1 in H_2SO_4 (190).

$C_{32}H_{22}N_4O_8S_2$.—Diphenyldisazo-*bis*- α -naphthol-2-sulfonic acid: Na salt (424q).

$C_{32}H_{22}N_4O_{11}S_3$.—Diphenyldisazo-8-sulfo- β -naphthol- α -naphthol-4, 8-disulfonic acid (Na salt, C. I. 386): metallic salts in H_2O ; Al, 542, Ba, 540, Cu, 515 (677).

$C_{32}H_{23}N_5O_7S_2$.—Diphenyldisazo-8-sulfo- β -naphthol- α -naphthylamine-4-sulfonic acid (Na salt, C. I. 376): Congo Rubino (498).

Diphenyldisazo-4-sulfo- α -naphthylamine- α -naphthol-4-sulfonic acid (Na salt, C. I. 375): (269). Metallic salts in H_2O ; Na, 520, Al, 518, Cu, 495 (677).

$C_{32}H_{23}N_7O_{10}S_3$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo- α -naphthaleneazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, 576 in H_2O (572 with alkali, 578 with acid) (436).

$C_{32}H_{23}N_7O_{13}S_4$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo-7-sulfo- α -naphthaleneazo-6-amino- α -naphthol-3-sulfonic acid: Na salt, 555 in H_2O (551 with alkali, 566 with acid) (436).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo-7-sulfo- α -naphthaleneazo-6-amino- α -naphthol-4-sulfonic acid: Na salt, 581 in H_2O (569 with alkali, 580 with acid) (436).

$C_{32}H_{24}N_6O_8S_2$.—Diphenyldisazo-*bis*- α -naphthylamine-4-sulfonic acid (Na salt, Congo Red, C. I. 370): 497, 319 in alk. EtOH; 577, (320) in dil. H_2SO_4 (215); *cf.* (468, 525); 500 on cotton (627); influence of concn. (269); quant. data (162q).

$C_{32}H_{24}N_6O_7S_2$.—Diphenyldisazo-4-sulfo- α -naphthylamine-7-amino- α -naphthol-3-sulfonic acid (Na salt): Pontamine Bordeaux B, metallic salts in H_2O ; Na, 510, Ba, 505, Cr, 480, Al, 480 (677).

$C_{32}H_{24}N_6O_8S_2$.—Diphenyldisazo-*bis*-7-amino- α -naphthol-3-sulfonic acid (Na salt, C. I. 394): Pontamine Violet N, 520 in H_2O (concd.); 525 (dil.) (269); 545 in EtOH (266); Ba salt, 510 in H_2O (677). Erie Violet 3R identical with above when heated. When dissolved in cold—640, 585 in H_2O (545 in EtOH) (269); *cf.* (266); Ba salt, 635, 590 in H_2O (677).

$C_{32}H_{24}N_6O_{14}S_4$.—Diphenyldisazo-*bis*-8-amino- α -naphthol-3, 6-disulfonic acid (Na salt, C. I. 406): Pontamine Blue BBF, metallic salts in H_2O ; Na, Ba, 580, Cu, 590, Al, 570, Cr, 595 (677).

$C_{32}H_{27}N_6O_9S_2$.—4-Sulfo-2-methylbenzeneazo-*p*-methylanisoleazo-6-benzoylamino- α -naphthol-3-sulfonic acid: Na salt, 641, (598), 530 in H_2O ; 638, 522 in 0.02*N* HCl; (630), 542 in 0.02*N* NaOH; 571, 542 in 85% EtOH (436).

$C_{32}H_{27}N_9$.—Benzeneazobenzeneazobenzeneazobenzeneazodimethylaniline: 514 (111).

$C_{33}H_{26}N_6O_6S_2$.—*m*-Sulfobenzeneazo- α -naphthaleneazo-*p*-tolyl- α -naphthylamine-*S*-sulfonic acid (Na salt, C. I. 289): influence of neutral salts (635, 636); influence of concn. (269).

$C_{33}H_{26}N_8O_{15}S_4$.—3, 3'-Disulfodiphenylurea-4, 4'-disazo-*bis*-7-amino- α -naphthol-3-sulfonic acid (Na salt, C. I. 353): soln. and dyeing (22); influence of concn. (269).

$C_{34}H_{24}N_8O_{10}S_2$.—Phenolazodiphenylazo-*S*-amino-3, 6-disulfo- α -naphtholazo-*p*-nitrobenzene (Na salt, C. I. 593): Pontamine Green X (269).

$C_{34}H_{26}N_4O_2$.—Ditolylidazo-*bis*- β -naphthol: 654.2, 606.1 in H_2SO_4 (190).

$C_{34}H_{26}N_4O_4$.—Dimethoxydiphenyldisazo-*bis*- β -naphthol (C. I. 499): 663.2, 614.2 in H_2SO_4 (190).

$C_{34}H_{26}N_4O_{10}S_2$.—Dimethoxydiphenyldisazo-*bis*- α -naphthol-4-sulfonic acid (Na salt, C. I. 502): Pontamine Blue AX, metallic salts in H_2O ; Na, 552, Cr, 550, Ba, 540, Al, Cu, 520 (677).

$C_{34}H_{27}N_5O_8S_2$.—7-Sulfo- α -naphthaleneazo-*p*-methylanisoleazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, 560 in H_2O ; 569 in 0.02*N* HCl; 550 in 0.02*N* NaOH (436).

$C_{34}H_{27}N_5O_{11}S_3$.—3, 6-Disulfo- α -naphthaleneazo-*p*-methylanisoleazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, (608), 556 in H_2O ; 554 in 0.02*N* HCl; 553 in 0.02*N* NaOH (436).

3, 6-Disulfo- β -naphthaleneazo-*p*-methylanisoleazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, 555 in H_2O ; 555 in 0.02*N* HCl; 558 in 0.02*N* NaOH; 582, 555 in 85% EtOH (436).

3, 6-Disulfo-*S*-amino- α -naphtholazoditolylazo- α -naphthol-4-sulfonic acid (Na salt, C. I. 472): Niagara Blue BR, 568 in H_2O at 23°; 567 at 49°; 565 at 76° (677).

$C_{34}H_{27}N_5O_{12}S_3$.—3, 7-Disulfo- β -naphtholazoethoxybenzidineazo-7-amino- α -naphthol-3-sulfonic acid (Na salt, C. I. 492): 580 in H_2O (dissolved cold); 575 (dissolved hot); 565 in EtOH (266); cf. (269).

$C_{34}H_{27}N_5O_{14}S_4$.—3, 6, 8-Trisulfo- β -naphthaleneazo-*p*-methylanisoleazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, 562 in H_2O ; 561 in 0.02*N* HCl; 560 in 0.02*N* NaOH; 580, 556 in 85% EtOH (436).

$C_{34}H_{28}N_6O_6S_2$.—Ditolylidazo-*bis*- α -naphthylamine-4-sulfonic acid (Na salt, C. I. 448): Erie Red 4B, 490 in H_2O (concd.); 498 (dil.); 505 in EtOH (269). Purpurine 4B (DuP.), 490 in H_2O (concd.), 496 (dil.), 510 in EtOH (677). Benzopurpurine 4B (By), on cotton, 505 (627). Diamine Red 4B, 512.5 on cotton (627).

Ditolylidazo-*bis*- α -naphthylamine-5-sulfonic acid (Na salt, C. I. 449). Metallic salts of Benzopurpurine 6B in H_2O : Na, Cu, Al, 500; Cr, 505 (677).

$C_{34}H_{28}N_6O_9S_2$.—Ethoxydiphenyldisazo-*bis*-7-amino- α -naphthol-3-sulfonic acid (Na salt, C. I. 493): Diamine Black BO, dissolved with heat, 600 in H_2O (concd.); 580 (dil.); dissolved cold, 580 in H_2O (concd.); 570 (dil.); 570 in EtOH (266); cf. (269).

$C_{34}H_{28}N_6O_9S_3$.—Ditolylidazo-3, 6-disulfo- β -naphthylamine- β -naphthylamine-6-sulfonic acid (Na salt, Vital Red, C. I. 456): 500 in H_2O (269).

$C_{34}H_{28}N_6O_{14}S_4$.—Ditolylidazo-*bis*-*S*-amino- α -naphthol-3, 6-disulfonic acid (Na salt, Trypan Blue, C. I. 477): 585 in H_2O (485a); cf. (473).

$C_{34}H_{28}N_6O_{16}S_4$.—Dimethoxydiphenyldisazo-*bis*-*S*-amino- α -naphthol-3, 6-disulfonic acid (Na salt, C. I. 520): Pontamine Sky Blue 5BX, 595 in H_2O (concd.), 603 (dil.) (269). Metallic salts in H_2O : Na, 603, Al, 605, Cr, 610, Ba, 610, Cu, 580 (677).

Dimethoxydiphenyldisazo-*bis*-*S*-amino- α -naphthol-5, 7-disulfonic acid (Na salt, C. I. 518): Pontamine Sky Blue 6BX, lakes with Methylene Blue (265). Metallic salts in H_2O : Na, 620, Cu, 620, 670, Cr, 590, Ba, 618 (677).

$C_{35}H_{27}N_5O_{12}S_3$.—3, 6-Disulfo- β -naphthaleneazo-*p*-methylanisoleazo-6-benzoylamino- α -naphthol-3-sulfonic acid: Na salt (601),

535 in H_2O ; 516 in 0.02*N* HCl; 543 in 0.02*N* NaOH; 560 in 85% EtOH (436).

$C_{35}H_{27}N_5O_{15}S_4$.—3, 6, 8-Trisulfo- β -naphthaleneazo-*p*-methylanisoleazo-6-benzoylamino- α -naphthol-3-sulfonic acid: Na salt, (596), 540 in H_2O ; 535 in 0.02*N* HCl; 543 in 0.02*N* NaOH; 576, 538 in 85% EtOH (436).

$C_{38}H_{27}N_7O_{10}S_3$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo- α -naphthaleneazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, 593 in H_2O (580 with alkali, 621 with acid) (436).

$C_{38}H_{27}N_7O_{13}S_4$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo-7-sulfo- α -naphthaleneazo-6-phenylamino- α -naphthol-3-sulfonic acid: Na salt, 575 in H_2O (556 with alkali, 578 with acid) (436).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo-7-sulfo- α -naphthaleneazo-6-phenylamino- α -naphthol-4-sulfonic acid: Na salt, 601 in H_2O (580 with alkali, 608 with acid) (436).

$C_{39}H_{29}N_7O_{10}S_3$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo- α -naphthaleneazo-6-*p*-tolylamino- α -naphthol-3-sulfonic acid: Na salt, 595 in H_2O (587 with alkali, 620 with acid) (436).

$C_{39}H_{29}N_7O_{13}S_4$.—*p*-Sulfobenzeneazo-*o*-sulfobenzeneazo-7-sulfo- α -naphthaleneazo-6-*p*-tolylamino- α -naphthol-3-sulfonic acid: Na salt, 578 in H_2O (560 with alkali, 579 with acid) (436).

p-Sulfobenzeneazo-*o*-sulfobenzeneazo-7-sulfo- α -naphthaleneazo-6-*p*-tolylamino- α -naphthol-4-sulfonic acid: Na salt, 603 in H_2O ; (576 with alkali, 604 with acid) (436).

$C_{46}H_{34}N_{10}O_{13}S_3$.—4-Sulfo- α -naphthaleneazo-3, 6-disulfo- α -naphthol-7-azo-*m*-toluylenediamineazodiphenylazosalicylic acid (Na salt, C. I. 561): Trisulfon Brown B (22).

Diazine Black D. R. Concd. (probably identical with Zambesi Black II): 560 in H_2O (concd.); 565 (dil.); 585 in EtOH (266, 269).

Diazo Dark Blue 3B: 560 in H_2O (concd.), 570 (dil.), 590 in EtOH (266, 269).

Pontachrome Yellow 3R: on wool (10).

Pontamine Copper Blue RRX (probably N. W. acid \rightarrow benzidine \rightarrow 2-amino-8-naphthol-5-sulfonic acid): 545 in H_2O (concd.); 555 (dil.) (269). Metallic salts in H_2O : Na, 555, Ba, 550, Al, 510, Cu, 530 (677).

TABLE 3.—TRIPHENYLMETHANE DERIVATIVES

$C_{19}H_{10}Br_4O_2$.—*m*-Tetrabromobenzaurin (subst. in phenol residues): 583 in alk. H_2O (461).

$C_{19}H_{13}BrO_2$.—*o*-Bromobenzaurin (subst. in benzene residue): 568 in alk. H_2O (461).

m-Bromobenzaurin (subst. in benzene residue): 565 in alk. H_2O (461).

p-Bromobenzaurin (subst. in benzene residue): 539 in alk. H_2O (461).

$C_{19}H_{13}BrN_2O_4$.—*p*-Bromo-*p*-dinitrotriphenylmethane: 274 in EtOH; Na salt, 513 in EtOH and C_6H_6 (221).

$C_{19}H_{13}N_3O_6$.—*p*-Trinitrotriphenylmethane: Na salt, 549 in EtOH (221).

$C_{19}H_{14}O$.—Fuchsone: 381, 262, 250 in EtOH; 462, 402, (289), 248 in concd. H_2SO_4 ; 472, 381, 283, 278, 270 in EtOH + HCl; 286, 250, in EtOH + KOH (491a); 379, (262) in $CHCl_3$ (219); (471 with excess $SnCl_4$ (438)); cf. (213, 218, 438, 442, 454, 470).

$C_{19}H_{14}O_2$.—Benzaurin: 435, 343, (284), 275 in EtOH; 504, 402, (284, 276, 266) in EtOH + HCl; 473, 410, (292, 285?), 256 in concd. H_2SO_4 ; 567, 379, 296, 250 in EtOH + KOH; 345, 296, 247 in 33% KOH (489a); cf. (155, 438, 442, 454, 461, 463, 491a).

$C_{19}H_{14}O_3$.—Aurin: 463, (385, 297, 276), 265 in EtOH; 476, (428, 333, 298, 289), 260 in concd. H_2SO_4 ; 482, (338, 309), 272, 266 in EtOH + HCl; 536, (500), 283 in EtOH + KOH; (364), 298, 248 in concd. aq. KOH (491a); cf. (57, 155, 174, 196, 231, 454, 461, 525),

$C_{19}H_{14}O_4$.—*o*-Dihydroxybenzaurin (subst. in phenol residues): 516 in alk. H_2O (467).

$C_{19}H_{14}O_5$.—*o*-Dihydroxyaurin: 545 in alk. H_2O (467).

$C_{19}H_{14}O_5S$.—*m*-Sulfobenzaurin (subst. in benzene residue): 560 in alk. H_2O (461).

p-Sulfobenzaurin (subst. in benzene residue): 568 in alk. H_2O ; 512 in acid H_2O (458).

m-Sulfobenzaurin (subst. in phenol residue): 559 in alk. H_2O (461).

$C_{19}H_{14}O_6$.—*o*-Trihydroxyaurin (resaurin): 498 in alk. EtOH (174).

m-Trihydroxyaurin (catechaurin): 583.5 in dil. $NaHCO_3$ soln. (461).

o-Hydroxy-*m*-dihydroxyaurin: 610 in alk. EtOH (174).

$C_{19}H_{15}Cl_3N_3(OAc)$.—*o*-Trichloro-*p*-rosaniline acetate: 533 in H_2O (440).

$C_{19}H_{15}N$.—Fuchsonimine: 430 in acid H_2O (461); chloride, 435, 335, 258 in EtOH (440); cf. (463).

$C_{19}H_{15}NO$.—*p*-Aminofuchsonine: 558 in H_2O (461).

$C_{19}H_{15}NO_2$.—*p*-Nitrotriphenylmethane: Na salt, 429 in EtOH + C_6H_6 (221).

o-Aminobenzaurin: 565 in H_2O (461).

p-Aminobenzaurin (C. I. 726): 539.1, 486.4 in alk. EtOH; 530.3, 477.4 in alk. H_2O (155); 497 in acid H_2O (461).

$C_{19}H_{15}Cl$.—Triphenylcarbonium chloride: abs. of alkylmercapto derivs. (549).

$C_{19}H_{15}N(ClO_4)$.—*p*-Aminotriphenylcarbinol anhydride perchlorate: 485, 420, 310 in HOAc (314).

$C_{19}H_{16}N_2O$.—*p*-Diaminofuchsonine (C. I. 726): 541 in H_2O (461).

$C_{19}H_{16}O$.—*p*-Hydroxytriphenylmethane: 278 in EtOH (442).

Triphenylcarbinol: 269, 265, 262, 259, 253, 248, 242 in EtOH (492q); 431, 404, (289, 262, 241) in concd. H_2SO_4 (491q); cf. (219, 314, 470). Ethyl ether (79). Methoxy derivs. (389q).

$C_{19}H_{16}O_2$.—*p*-Dihydroxytriphenylmethane: 289, 280, 271, 264, 258 in EtOH (489); cf. (370, 490).

p-Hydroxytriphenylcarbinol: (89).

$C_{19}H_{17}NCl$.—*p*-Aminotriphenylmethane chloride: 280 in EtOH (442).

$C_{19}H_{17}N_2Cl$.—*p*-Diaminotriphenylcarbinol anhydride chloride (Döbner's Violet): 561.6 in H_2O ; 577 in EtOH (155); 568, 399, 305 in EtOH (442). Diacid salt, 480 (314); cf. (465).

$C_{19}H_{17}N_3O_9S_3$.—Sulfonated *p*-rosaniline (Na salt) and its mono- and trimethyl isomers (162q). Commercial acid fuchsin: infra-red abs., 0.8, (2.0?), 2.8, (4.2?), (4.7?), (5.2?), 6.2, 7.4, 8.3, 9.2, 9.8, (10.2?), (10.7?) μ (296); ultra-violet band, 294 in H_2O (308 with NH_4OH) (352); on silk (627); on wool (522); cf. (269, 421q).

$C_{19}H_{18}N_3Cl$.—*p*-Rosaniline (C. I. 676): base, 555, 287 in EtOH (20); chloride, in H_2O , 540.3, 483.7 (155); in EtOH, 547, (490), 295 (314); in $NHCl$, 588, 405; in HCl , 476 (20); diacid salt, 585; triacid salt, 485 (314); in solid form (352); cyanide, 532, 290, 249 in EtOH (381); cf. (3, 162q, 269, 273q, 352, 461, 497, 509q).

With rosaniline (Fuchsin, C. I. 677): infra-red abs., 0.7, (1.7?), 2.8, (4.1?), (4.7?), 6.3, 7.5, 8.6, (9.6), 11.1 μ (296); (3.5, 6.5, 8.2 μ) (80); influence of concn. (269, 273); influence of temp. (57); cf. (286q, 334, 335); dyeings (522, 627); cf. (4, 114, 218, 299q, 508q).

$C_{20}H_{12}Br_4O_3$.—Tetrabromorosaniline acid: 566.4 in alk. H_2O ; 576.9 in alk. EtOH (350); influence of temp. (57).

$C_{20}H_{16}O_3$.—*p*-Methoxybenzaurin: 551 in alk. H_2O (467).

$C_{20}H_{16}O_3$.—Rosolic acid: 543.3 in alk. H_2O ; 569.4 in alk. EtOH (350); cf. (497).

$C_{20}H_{17}OCl$.—*o*-Methoxytriphenylcarbonium chloride: 550 in HOAc-HCl mixture (54q).

p-Methoxytriphenylcarbonium chloride: 470 in HOAc-HCl mixture (54q).

$C_{20}H_{20}N_3(Cl)$.—Rosaniline chloride: infra-red abs., 0.9, (1.6?), (2.7?), 6.3, 7.2, 7.8, 9.0, (9.4), 10.1, (10.5?), (11.3?) μ (296); 544.5 in H_2O (155); ultra-violet band at 291 in EtOH (289 with NH_3) (352); cf. (3, 231q, 273q, 647q). Phenolate (275).

$C_{21}H_{18}N_2O_3$.—*p*-Nitro-*p*-dimethylaminofuchsonine: "apparently 610" (467).

$C_{21}H_{19}NO$.—*p*-Dimethylaminofuchsonine: 586 in alk. H_2O ; 515, (530, 500) in acid H_2O (461); 468 in H_2SO_4 (470).

$C_{21}H_{19}NO_4$.—4-Dimethylamino-3', 4', 3'', 4''-tetrahydroxytriphenylcarbinol anhydride: 700 in alk. soln.; 595 in $NaHCO_3$ soln.; 565 in acid soln. (473).

$C_{21}H_{19}O_2Cl$.—*o*-Dimethoxytriphenylcarbonium chloride: 577, 495 in HOAc-HCl mixture (54q).

p-Dimethoxytriphenylcarbonium chloride: 500 in HOAc-HCl mixture (54q).

$C_{21}H_{20}NCl$.—*p*-Dimethylaminotriphenylcarbinol anhydride chloride: 485, 330, (290), (260) in very dil. acid (218); cf. (54q, 314, 442, 461, 464).

$C_{21}H_{21}N_2(Cl)$.—*sym.*-Dimethyl-*p*-diaminotriphenylmethane anhydride chloride: 587 in H_2O (155).

$C_{21}H_{22}N_3(Cl)$.—*asym.*-Dimethyl-*p*-rosaniline chloride: 547, 493 in H_2O (575 with acid) (467).

$C_{22}H_{21}O_3(Cl)$.—*o*-Trimethoxytriphenylcarbonium chloride: 546 in HOAc-HCl mixture (54q).

p-Trimethoxytriphenylcarbonium chloride: 480 in HOAc-HCl mixture (54).

$C_{22}H_{23}N_3O_9S_3$.—Ethylrosaniline trisulfonic acid (Na salt, C. I. 693): Red Violet 5RS, influence of concn. (269).

$C_{22}H_{24}N_3(Cl)$.—*p*-Triamino-*o*-tritolylicarbinol anhydride chloride (New Fuchsin, C. I. 678): 548.5 in H_2O (155); 541 in H_2O (concd.), 544 (dil.) (269); ultra-violet band at 292 in EtOH (290 with NH_3) (352); cf. (162q, 273q).

$C_{23}H_{16}O$.—Benznaphthaurin: 568 in H_2SO_4 (454).

$C_{23}H_{24}ClN_2(Cl)$.—*o*-Chloromalachite green: 630.1 in H_2O (151).

$C_{23}H_{24}N_2O$.—Tetramethyl-*p*-diaminofuchsonine: 540, 286 in EtOH; 521, 283 in $CHCl_3$; 461, 278 in Et_2O (218).

$C_{23}H_{24}N_2O_3S$.—Tetramethyl-*p*-diaminotriphenylcarbinol-*o*-sulfonic acid anhydride: Na salt, 623.9 in H_2O (155).

$C_{23}H_{24}N_3O_2(Cl)$.—*o*-Nitromalachite green: 633.1 in EtOH (151).

m-Nitromalachite green: 635.7 in EtOH (151).

p-Nitromalachite green: 637 in EtOH (151); 642 in H_2O (467).

$C_{23}H_{25}N_2(Cl)$.—Malachite green (C. I. 657): infra-red abs., 0.7, 3.4, 4.3, (4.8?), 6.5, 7.4, 8.5, (9.2), (10.6), (10.9), 11.2 μ (296); 616, 430 in H_2O (271); (400, 305 (419q)); influence of acidity (218, 219, 271, 306, 314, 463); influence of temp. (286); cf. (3, 54q, 111, 155, 352, 465, 525).

sym.-Diethyl-*p*-diaminotriphenylmethane carbinol anhydride chloride: 589.8 in H_2O (155).

$C_{23}H_{25}N_2O(Cl)$.—*o*-Hydroxymalachite green: 620.7 in H_2O (605.8, 560.3 with alkali); 617.7 in EtOH (155); cf. (111, 467).

m-Hydroxymalachite green: 617.4 in H_2O ; 618 in EtOH (155); cf. (111).

p-Hydroxymalachite green: 602.5 in H_2O (568.7, 518.6 with KOH); 599.5 in EtOH (558.5, 515.2 with KOH) (155); cf. (111, 174, 463).

$C_{23}H_{25}N_2O_2Cl$.—2, 4-Dihydroxymalachite green: 601 (acetate in EtOH + 1 mol HCl) (111).

3, 4-Dihydroxymalachite green: 603, 505 in acid EtOH (174).

$C_{23}H_{25}N_2O_3(Cl)$.—2, 3, 4-Trihydroxymalachite green: 612, 500 in acid EtOH (174); cf. (111).

$C_{23}H_{26}N_3(Cl)$.—*o*-Aminomalachite green: 616.2 in EtOH; 618.9 in H_2O ; 635.4 in dil. HCl (155); cf. (539).

m-Aminomalachite green: 614.7 in EtOH; 615.9 in H_2O ; 627.1 in dil. HCl (155); cf. (539).

$C_{23}H_{26}N_3(Cl)$.—*p*-Aminomalachite green. 576.2, 532.1 in AmOH; 578, 529.4 in EtOH; 586.3, 513.6 in H_2O ; 623.9 in dil. HCl (155); 420 in HCl (467); cf. (152, 539).

$C_{24}H_{26}N_2O_3S$.—Tetramethyl-*p*-diaminodiphenyl-*m*-tolylcarbinol-*o*-sulfonic acid anhydride: Na salt, 622.3 in H_2O (155).

$C_{24}H_{27}ClN_3(Ac)$.—2-Chloro-3-amino-5-methylmalachite green: 614.5 in H_2O (541).

2-Chloro-4-amino-5-methylmalachite green: 617.5 in H_2O (541).

3-Chloro-2-amino-5-methylmalachite green: 594.6 in H_2O (541).

4-Chloro-2-amino-5-methylmalachite green: 613.4 in H_2O (541).

4-Chloro-3-amino-6-methylmalachite green: 620.4 in H_2O (541).

5-Chloro-3-amino-2-methylmalachite green: 617.6 in H_2O (541).

5-Chloro-3-amino-6-methylmalachite green: 632.2 in H_2O (541).

5-Chloro-4-amino-2-methylmalachite green: 611.5 in H_2O (541).

$C_{24}H_{27}N_2Cl$.—*o*-Methylmalachite green: 618 in H_2O ; 619.5 in EtOH (155).

p-Methylmalachite green: 611.1 in H_2O , 614.7 in EtOH (155).

$C_{24}H_{27}N_2O(Cl)$.—*o*-Methyl-*p*-hydroxymalachite green: 617 in slightly acid H_2O ; 587 in alk. H_2O (461).

o-Methoxymalachite green: 602.1 in H_2O ; 601.1 in EtOH (155).

p-Methoxymalachite green: 603 in H_2O ; 603.6 in EtOH (155); 613, 465, 290 in dil. acid (218); cf. (111, 467).

$C_{24}H_{27}N_4O_2(Ac)$.—2-Nitro-3-amino-5-methylmalachite green: 661.4 in H_2O (541).

2-Nitro-3-amino-6-methylmalachite green: 617.5 in H_2O (541).

3-Nitro-2-amino-5-methylmalachite green: 595.4 in H_2O (541).

5-Nitro-4-amino-2-methylmalachite green: 602.1 in H_2O (541).

$C_{24}H_{28}N_3(Cl)$.—Pentamethyl-*p*-rosaniline: 583.3, 529.5 in H_2O ; 583.3, 538.5 in EtOH (155).

Commercial Methyl Violet: infra-red abs., 2.9, (4.4), 6.4, 7.2, 8.4, (9.1?), (9.4), 10.6 μ (somewhat different data with Paris Violet) (296); 540 in H_2O (concd.), 580 (dil.) (269); ultra-violet bands at 302, 247 in EtOH (260 with NH_3) (352); dyeings (170, 627); cf. (3, 162q, 274q, 419q).

Gentian Violet (274q); cf. (3, 114).

$C_{24}H_{28}N_3(Cl)$.—2-Amino-5-methylmalachite green: 618.5 in H_2O ; 635.3 in dil. HNO_3 ; 618.1 in EtOH (539).

3-Amino-2-methylmalachite green: 619.8 in H_2O ; 619.2 in EtOH (155); cf. (539).

3-Amino-4-methylmalachite green: 612.3 in H_2O ; 612.6 in EtOH (155); 624.1 in dil. HNO_3 ; 622.9 in acid EtOH (539).

3-Amino-6-methylmalachite green: 620.6 in H_2O ; 631.4 in dil. HNO_3 ; 619.1 in EtOH (630.1 with HNO_3) (539).

4-Amino-2-methylmalachite green: 601 in H_2O ; 590.4, 536.6 in EtOH (155); influence of acidity (539).

4-Amino-3-methylmalachite green: 582.7, 512.8 in H_2O ; 578, 529.9 in EtOH (155); 620.4 in dil. HNO_3 (539).

$C_{24}H_{28}N_3O_3S(Ac)$.—2-Sulfo-4-amino-5-methylmalachite green: 617.2 in H_2O (541).

4-Sulfo-2-amino-5-methylmalachite green: 590.8 in H_2O (541).

5-Sulfo-3-amino-2-methylmalachite green: 632.5 in H_2O (541).

5-Sulfo-3-amino-6-methylmalachite green: 632.2 in H_2O (541).

$C_{25}H_{24}N_3O_2(OAc)$.—Tetramethyl-*p*-diaminodiphenylisatinyl carbinol acetate: 599.1, 498.4 in H_2O (540).

$C_{25}H_{25}N_2O_7S_2$.—2, 4-Disulfo-5-hydroxydiethyl-*p*-diaminophenyliditolyl carbinol anhydride, Na salt (C. I. 715): Cyanole Extra, 612.5 in H_2O (606.3 with alkali); 611.3 in EtOH (267q). Cyanole FF, 622 on silk (627).

$C_{25}H_{29}N_2O(Cl)$.—*o*-Ethoxymalachite green: 606.7 in H_2O ; 603.3 in EtOH (155).

p-Ethoxymalachite green: 605.3 in H_2O ; 605.8 in EtOH (155).

$C_{25}H_{30}N_3(Cl)$.—Hexamethyl-*p*-rosaniline (Crystal Violet, C. I. 681): 590.5, 539.5 in H_2O ; 591.1, 544.5 in EtOH (155); ultra-

violet bands at 305, 249 in EtOH (260 with NH_3) (352); diacid salt, 626 (2% H_2SO_4); triacid salt 490–495 (HCl) (314); triacid salt, 440, (312), 261 (H_2SO_4) (219); influence of concn. (269); dyeings (522, 627); lake with paper stock (265); in solid form, 540 (269); dye base, 590 in EtOH; 588 in Me_2CO ; 490–495 in C_6H_6 (677); pseudo-base, 262 in EtOH (213); resorcinol addition product (278); cyanide, 268 in EtOH (381); cf. (2q, 54q, 111, 114q, 162q, 218, 274q, 276, 299q, 461, 463, 465, 518q).

$C_{26}H_{26}N_3O_2(OAc)$.—Tetramethyl-*p*-diaminodiphenyl-*o*-methylisatinylcarbinol acetate: 594.3, 503.7 in H_2O (540).

Tetramethyl-*p*-diaminodiphenyl-*p*-methylisatinylcarbinol acetate: 626.2 in H_2O (540).

$C_{26}H_{31}N_2(Cl)$.—*p*-Isopropylmalachite green: 614, 440 in H_2O ; 462 in dil. H_2SO_4 (271).

$C_{26}H_{32}N_3(Cl)$.—*m*-Dimethylamino-*o*-methylmalachite green: 618.9 in H_2O ; 620.7 in EtOH (155).

m-Dimethylamino-*p*-methylmalachite green: 614.4 in H_2O ; 615.6 in EtOH (155).

p-Dimethylamino-*o*-methylmalachite green: 589.2, 545.5 in H_2O ; 598.8, 551.5 in EtOH (155).

p-Dimethylamino-*m*-methylmalachite green: 589.3, 534.8 in H_2O ; 590.6, 542.5 in EtOH (155).

Triethylrosaniline (Hofmann's Violet, C. I. 679): 540 in H_2O (concd.); 585 (dil.) (269); cf. (231).

$C_{26}H_{33}ClN_3(Cl)$.—Heptamethyl-*p*-rosaniline (Methyl Green, C. I. 684): infra-red abs., 0.7, (2.0?), 3.0, 3.9, (4.5?), (5.1?), (5.5?), 6.3, 7.4, 8.8, 10.3 μ (296); cf. (3, 162q, 269, 511).

$C_{27}H_{27}N_3O_6S_2$.—Tetramethyltriaminodiphenyl- α -naphthylcarbinoldisulfonic acid anhydride, Na salt (C. I. 733): Intensive Blue, 612, (540) in H_2O (concd.); 615 (dil.) (269).

$C_{27}H_{35}N_2O_6S_2$.—Tetraethyldiaminotriphenylcarbinol-2, 4-disulfonic acid anhydride, Na salt (C. I. 672): Xylene Blue VS, 640 in H_2O ; 632.5 in EtOH (267q).

Tetraethyldiaminotriphenylcarbinol-2, 5-disulfonic acid anhydride: Na salt, Alphazurine 2G, 640 in H_2O ; 631.3 in EtOH (267q).

$C_{27}H_{32}N_2O_7S_2$.—2,4-Disulfo-5-hydroxytetraethyldiaminotriphenylcarbinol anhydride, Ca salt (C. I. 712): Patent Blue V, 637.5 in H_2O (627.5 with alkali); 630 in EtOH (267q); ultra-violet bands, 390, 305 (419); 410, 308 in EtOH (352); dyeings (522).

$C_{27}H_{32}N_2O_3S$.—*o*-Sulfotetraethyldiaminotriphenylcarbinol anhydride: Na salt, 630.8 in H_2O (155).

$C_{27}H_{33}N_2(Cl)$.—Tetraethyl-*p*-diaminotriphenylcarbinol anhydride chloride (Brilliant Green, C. I. 662): infra-red abs., 0.7, 1.3, (5.2), 6.4, 7.1, 7.5, (8.5), 9.0, 9.8, 10.8, 11.3 μ (296); 623 in H_2O (155); influence of concn. (269); influence of temp. (426); dyeings (522, 627); solid dye (546); ultra-violet bands at 429, 313 in EtOH (352).

$C_{27}H_{33}N_2O(Cl)$.—*m*-Hydroxybrilliant green: 623.6 in H_2O (155).

$C_{27}H_{34}N_3(Cl)$.—*o*-Dimethyl crystal violet: 605 in H_2O ; 605, 560.3 in EtOH; 605.8, 562.5 in AmOH (155).

Tetraethyl-*p*-rosaniline: 591.4, 517.7 in H_2O ; 582.5, 533 in EtOH; 580.7, 535.7 in AmOH (155).

$C_{29}H_{21}(Cl)$.—Phenyldiphenyl-naphthylchloromethane: 595, 495 in $HOAc-H_2SO_4$ mixture; 620, 495 in C_6H_5OH (98).

$C_{29}H_{23}NO_2$.—*p*-Dimethylamino-*p*-dihydroxyphenyldinaphthylcarbinol anhydride: 730 in H_2O (492 with acid) (467).

$C_{29}H_{29}N_4(OAc)$.—*p*-Azobenzenemalachite green: 572 in EtOH + 1 mol HCl (111).

$C_{29}H_{29}N_4O(OAc)$.—*m*-Azobenzene-*o*-hydroxymalachite green: 557 in EtOH + 1 mol HCl (111).

p-Azophenolmalachite green: 556 in EtOH + 1 mol HCl (111).

m-Azophenolmalachite green: 565 in EtOH + 1 mol HCl (111).

$C_{29}H_{29}N_4O_2(OAc)$.—*p*-Azoresorcinolmalachite green: 565 in EtOH + 1 mol HCl (111).

m-Azophenol-*o*-hydroxymalachite green: 565 in EtOH + 1 mol HCl (111).

$C_{29}H_{29}N_4O_3(OAc)$.—*p*-Azopyrogallolmalachite green: 567 in EtOH + 1 mol HCl (111).

$C_{29}H_{30}N_3(Cl)$.—*p*-Phenylaminomalachite green: 594, 538.5 in H_2O ; 594, 549.5 in EtOH; 594, 552.6 in AmOH (31); cf. (152).

$C_{29}H_{32}N_3(Cl)$.—Tetramethylethyltriaminodiphenyl- α -naphthylcarbinol chloride (Victoria Blue R, C. I. 728): 565 in H_2O (concd.); 605 (dil.) (269).

$C_{30}H_{28}N_3(Cl)$.—Acridylmalachite green: 642 in H_2O (523).

$C_{30}H_{31}N_4O(OAc)$.—*p*-Azoanisolemalachite green: 561 in EtOH + 1 mol HCl (111).

$C_{30}H_{32}N_3(Cl)$.—*p*-Benzylaminomalachite green: 583.3, 526.7 in H_2O ; 583.3, 537.5 in EtOH; 583.5, 540.5 in AmOH (155); cf. (152).

$C_{31}H_{33}N_3O_9S_3$.—Benzylpentamethyltriaminotriphenylcarbinol-trisulfonic acid anhydride (Na salt, Acid Violet 4BN, C. I. 695): 550 in H_2O (concd.); 590 (dil.) (269).

$C_{31}H_{34}N_3(Cl)$.—Benzylpentamethyl-*p*-rosaniline (Benzyl Violet, C. I. 683): 587, 535.7 in H_2O (152); cf. (274q).

$C_{31}H_{34}N_5(OAc)$.—*p*-Azodimethylanilinomalachite green: 557 in EtOH + 1 mol HCl (111).

$C_{31}H_{42}N_3(Cl)$.—Hexaethyl-*p*-rosaniline (Ethyl Violet, C. I. 682): 596.1, 545.5 in H_2O ; 596, 550.5 in EtOH; 596.6, 552.6 in AmOH (155); influence of concn. (269, 274q).

$C_{32}H_{28}N_3(Cl)$.—Diphenylrosaniline and homologs (C. I. 689): Aniline Blue 2B (511q, 528q).

$C_{32}H_{29}N_3O_4S$.—Diphenyltriaminodiphenyltolylcarbinolsulfonic acid (Na salt, with triphenyl isomer, Alkali Blue, C. I. 704): (334q).

$C_{32}H_{35}N_3O_{10}S_3$.—Tetramethyl-*p*-tolyltriaminoethoxytriphenylcarbinoltrisulfonic acid anhydride (Na salt, C. I. 717): Pontacyl Violet 6BN, 540, 620 in H_2O (concd.); 620 (dil.); 610 in EtOH (269). Acid Violet 6BN (B), dyeings (522).

$C_{32}H_{36}N_3(Cl)$.—Tetramethylethylbenzyl-*p*-rosaniline: 585.7, 535.7 in H_2O (152).

$C_{33}H_{32}N_3(Cl)$.—Tetramethylphenyltriaminodiphenyl- α -naphthyl carbinol anhydride chloride (Victoria Blue B, C. I. 729): 618.8, (567) in H_2O (155); 565 in H_2O (concd.); 615 (dil.) (269). Base, 605 in EtOH; 482 in C_6H_6 (677).

$C_{34}H_{34}N_3(Cl)$.—Pentamethyl- α -naphthyl-*p*-rosaniline (Victoria Blue 4R, C. I. 690): 545 in H_2O (concd.); 590 (dil.) (269); cf. (3).

$C_{34}H_{39}N_3O_3S$.—Methyltetraethylphenyltriaminotriphenylcarbinolsulfonic acid anhydride (C. I. 700): Alkali Violet R, 540 in H_2O (concd.); 590 (dil.) (269).

$C_{35}H_{33}N_6O(OAc)$.—*p*-Azobenzeneazophenolmalachite green: 558 in EtOH + 1 mol HCl (111).

m-Azobenzeneazophenolmalachite green: 578 in EtOH + 1 mol HCl (111).

$C_{35}H_{34}N_6O$.—*p*, *p'*-Disazodimethylanilinetriphenylcarbinol: 505 in concd. HCl (111).

$C_{35}H_{34}N_6O_2$.—*p*-Hydroxy-*p'*, *p''*-disazodimethylanilinetriphenylcarbinol: 514 in concd. HCl (111).

$C_{36}H_{35}N_7(OAc)$.—*p*-Azobenzeneazodimethylanilinomalachite green: 558 in EtOH + 1 mol HCl (111).

$C_{37}H_{29}N_3O_6S_2$.—Triphenyltriaminotriphenylcarbinoldisulfonic acid anhydride (Na salt, C. I. 705): Soluble Blue (DuP.), 550 in H_2O (concd.); 560 (dil.) (269).

$C_{37}H_{29}N_3O_9S_3$.—Triphenyltriaminotriphenylcarbinoltrisulfonic acid anhydride (Na salt, C. I. 706): Methyl Blue, ultra-violet band at (380) in H_2O (301 with NH_3) (352).

$C_{27}H_{30}N_3(Cl)$.—Triphenyl-*p*-triaminotriphenylcarbinol anhydride chloride: 594.8 in EtOH (155); 594.8 in H_2O (151).

$C_{37}H_{31}N_3O_4S$.—Triphenyltriaminotriphenylcarbinolsulfonic acid anhydride (Na salt, C. I. 703): Methyl Alkali Blue (M. I. B.), 585 in H_2O (concd.); 590 (dil.) (269); Alkali Blue (305) in H_2O (300 with NH_3) (352).

$C_{37}H_{36}N_2O_6S_2$.—Dibenzyl-diethyldiaminotriphenylcarbinol-2, 4-disulfonic acid anhydride (Na salt, C. I. 673): 637.5 in H_2O ; 630 in EtOH (267q).

Dibenzyl-diethyldiaminotriphenylcarbinol-2, 5-disulfonic acid anhydride: Na salt, 637.5 in H_2O ; 630 in EtOH (267q).

Dibenzyl-diethyldiaminotriphenylcarbinoldisulfonic acid anhydride (Na salt, Guinea Green, C. I. 666): infra-red abs., 0.7, 3.1, 5.2, 6.4, 7.2, 7.5, (8.2), 9.0, 9.8, 10.8, 11.3 μ (296); dyeings (522); cf. (211q).

$C_{37}H_{36}N_2O_7S_2$.—2, 4-Disulfo-5-hydroxydibenzyl-diethyldiaminotriphenylcarbinol anhydride (Ca salt, Patent Blue A, C. I. 714): 637.5 in H_2O ; (627.5 in alk.); 630 in EtOH (267q).

$C_{37}H_{36}N_2O_9S_3$.—Dibenzyl-diethyldiaminotriphenylcarbinol-*p*, *p'*, *o''*-trisulfonic acid anhydride (NH_4 salt, Alphazurine FG, C. I. 671): 630 in H_2O ; 628.8 in EtOH (267q).

Dibenzyl-diethyldiaminotriphenylcarbinol-*p*, *p'*, *p''*-trisulfonic acid anhydride (Na salt, C. I. 670): 634, 425, 317 in H_2O (179q); 433, 313 in EtOH (311, 264 with NH_3) (352); dyeings (522, 590); cf. (419q, 422q, 519q).

$C_{37}H_{36}N_2O_{10}S_3$.—Fast Green FCF (*p*-hydroxyerioglaucine A): disodium salt, 628 in H_2O ; trisodium salt, 611; indicator application (283q).

$C_{37}H_{37}N_3O_6S_2$.—Tetramethyl-*p*-diaminodibenzyl-*m*-aminotriphenylcarbinoldisulfonic acid anhydride (Na salt, C. I. 691): Fast Green extra, 628, 590 in H_2O (concd.); 622 (dil.); Fast Green CR and extra blue shade, 630 in concd. and dil. solns. (269).

$C_{37}H_{38}N_3(Cl)$.—Tetramethyldibenzyl-*p*-triaminotriphenylcarbinol anhydride chloride: 588, 532 in H_2O ; 588.5, 542.5 in EtOH; 588.8, 544.5 in AmOH (152).

$C_{37}H_{39}N_7O$.—*p*-Dimethylamino-*p'*, *p''*-disazodimethylanilinetriphenylcarbinol: 516 in concd. HCl (111).

$C_{38}H_{33}N_3(Cl)$.—Triphenylrosaniline: 596.1 in EtOH (155); 597.4 in H_2O (151).

$C_{38}H_{42}N_3(Cl)$.—Tetraethyl-*p*-tolyltriaminodiphenyl- α -naphthylcarbinol anhydride chloride (Night Blue, C. I. 731): 570 in H_2O (concd.); 620 (dil.) (269).

$C_{40}H_{36}N_3O_9S_3$.—Trimethyltriphenyltriaminotriphenylcarbinol-trisulfonic acid anhydride (Na salt, C. I. 708): Hoechst New Blue, 311 in H_2O (306 with NH_3) (352).

$C_{41}H_{38}N_8$.—*p*-Azobenzene-*p'*, *p''*-disazodimethylanilinetriphenylmethane: 507 in concd. HCl (111).

$C_{41}H_{38}N_8O$.—*p*-Azophenol-*p'*, *p''*-disazodimethylanilinetriphenylmethane: 507 in concd. HCl (111).

$C_{41}H_{46}N_3O_6S_2$.—Dibenzyltetraethyltriaminotriphenylcarbinoldisulfonic acid anhydride (Na salt, C. I. 698): Pontacyl Violet C4B, 540 in H_2O (concd.); 590 (dil.) (269); cf. (276); Formyl Violet S4B, 599.8 on silk (627).

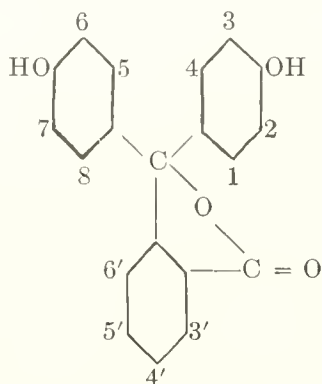
$C_{43}H_{43}N_9$.—*p*-Trisazodimethylanilinetriphenylmethane: 507 in concd. HCl (111).

$C_{46}H_{48}N_4(OAc)_2$.—Dimalachite green (diacetate): 622 (111).

Miscellaneous: Acid Violet, 300 in H_2O (309 with NH_3) (251); Acid Violet 4B extra (By), 530 in H_2O (concd.); 575 (dil.) (269); Acid Violet 6B, 535 in H_2O (concd.); 570 (dil.) (269); cf. (419); Alkali Blue 6B (By), 590 in H_2O (concd.); 580 (dil.) (269); Bavarian Blue DSF, 580 in H_2O (concd.); 595 (dil.) (269); Corallin, 460 in EtOH (concd.); 480 (dil.) (269); cf. (299q); Cotton Blue 6B extra, 311 in EtOH (294 with NH_3) (352); Guinea Violet 4B, dyeings (522); Iodine Green (231); Methyl Blue, infra-red abs., 0.7, 3.3, 5.2, 6.5, 7.3, 8.7, 9.5, 10.2, 10.4, (10.8), 11.4 μ (296); Neptune Green, infra-red abs. (296); New Patent Blue, 625 in H_2O ; 617.5 in EtOH (26q); New Patent Blue 4B, 615 in H_2O , 608.8 in EtOH

(267q); Pontacyl Blue R, 575 in H_2O (concd.), 620 (dil.) (269); Pure Blue, 595 on cotton, 600, 580 on silk (522); Water Blue, influence of concn. (299); Water Blue 6B, 305 (419q).

TABLE 4.—PHTHALEINS AND SULFONPHTHALEINS



See also Table 5 for other so-called phthalains

$\text{C}_{19}\text{H}_{10}\text{Br}_2\text{Cl}_2\text{O}_5\text{S}$.—Dibromodichlorophenolsulfonphthalein ("Brom chlor phenol blue"): 596 in alk. soln. (81q); cf. (433q).

$\text{C}_{19}\text{H}_{10}\text{Br}_4\text{O}_5\text{S}$.—2, 3, 6, 7-Tetrabromophenolsulfonphthalein ("Brom phenol blue"): 593 in alk. soln. (81q); 440 in acid soln. (613q); cf. (58, 433q, 465).

$\text{C}_{19}\text{H}_{12}\text{Br}_2\text{O}_5\text{S}$.—Dibromophenolsulfonphthalein ("Brom phenol red"): 574 in alk. soln. (81q); cf. (433q).

$\text{C}_{19}\text{H}_{12}\text{Cl}_2\text{O}_5\text{S}$.—Dichlorophenolsulfonphthalein ("Chlor phenol red"): 573 in alk. soln. (81q); cf. (433q).

$\text{C}_{19}\text{H}_{14}\text{O}_5\text{S}$.—Phenolsulfonphthalein ("Phenol red"): 559 in alk. H_2O ; 507 in acid H_2O , 435 in "mid-form" (270); 433, (318), 265 in H_2O ; 509, (429, 396, 320, 284), 270 in abs. EtOH; 500, 376, (327), 265 in concd. H_2SO_4 ; 562, 360, 288 in alk. H_2O (178q); cf. (45, 58, 66q, 271, 288q, 433q, 455, 461, 465).

$\text{C}_{19}\text{H}_{14}\text{O}_7\text{S}$.—Catecholsulfonphthalein: 600 in NaHCO_3 soln.; 557 in dil. HCl (461).

$\text{C}_{20}\text{H}_4\text{Cl}_{10}\text{O}_4$.—1, 2, 3, 4, 5, 6, 7, 8, 4', 5'-Dekaachlorophenolphthalein: 642 in alk. H_2O (462).

$\text{C}_{20}\text{H}_6\text{Br}_4\text{Cl}_4\text{O}_4$.—2, 3, 6, 7-Tetrabromo-3', 4', 5', 6'-tetrachlorophenolphthalein: 610, 377, 304 in alk. H_2O ; 615, 306 in alk. EtOH (288q); cf. (45q, 287).

$\text{C}_{20}\text{H}_6\text{Br}_8\text{O}_4$.—2, 3, 6, 7, 3', 4', 5', 6'-Octabromophenolphthalein: 608 in alk. H_2O ; 577 in H_2SO_4 (454).

$\text{C}_{20}\text{H}_6\text{Cl}_4\text{I}_4\text{O}_4$.—3', 4', 5', 6'-Tetrachloro-2, 3, 6, 7-tetraiodophenolphthalein: 621, 389, 308.5 in alk. H_2O ; 625, 308 in alk. EtOH (288q); cf. (45q, 287).

$\text{C}_{20}\text{H}_7\text{Br}_7\text{O}_4$.—2, 3, 6, 7, 3', 4' (?), 5'-Heptabromophenolphthalein: 609 in alk. H_2O (462).

$\text{C}_{20}\text{H}_8\text{Br}_6\text{O}_4$.—2, 3, 4 (?), 6, 7, 5' (?)—Hexabromophenolphthalein: 605 in alk. H_2O (462).

2, 3, 6, 7, 3', 5'-Hexabromophenolphthalein: 602 in alk. H_2O (462).

2, 3, 6, 7, 3', 6'-Hexabromophenolphthalein: 606 in alk. H_2O (462).

2, 3, 6, 7, 4', 5' (?)—Hexabromophenolphthalein: 592 in alk. H_2O (462).

$\text{C}_{20}\text{H}_9\text{Br}_4\text{IO}_4$.—2, 3, 6, 7-Tetrabromo-4-iodophenolphthalein: 600 in alk. H_2O (462).

$\text{C}_{20}\text{H}_9\text{Br}_4\text{NO}_6$.—2, 3, 6, 7-Tetrabromo-3'-nitrophenolphthalein: 597 in alk. H_2O (467).

2, 3, 6, 7-Tetrabromo-5'-nitrophenolphthalein: 599 in alk. H_2O (467).

$\text{C}_{20}\text{H}_9\text{Br}_5\text{O}_4$.—2, 3, 4, 6, 7-Pentabromophenolphthalein: 602 in alk. H_2O (462).

2, 3, 6, 7, 3'-Pentabromophenolphthalein: 597 in alk. H_2O (462).

2, 3, 6, 7 (4' or 5')—Pentabromophenolphthalein: 592 in alk. H_2O (462).

$\text{C}_{20}\text{H}_9\text{I}_5\text{O}_4$.—Pentaiodophenolphthalein ("probably two isomers"): 596 in alk. H_2O (462).

$\text{C}_{20}\text{H}_{10}\text{Br}_4\text{O}_4$.—2, 3, 6, 7-Tetrabromophenolphthalein: 580, 392, 305 in alk. H_2O ; 588, 311.5 in alk. EtOH (288q); 529 in H_2SO_4 (454); cf. (45q, 287, 441, 445, 460, 638q).

3', 4', 5', 6'-Tetrabromophenolphthalein: 583 in alk. H_2O (462); 501 in H_2SO_4 (454).

$\text{C}_{20}\text{H}_{10}\text{Cl}_4\text{O}_4$.—Tetrachloro-*o*, *p*-phenolphthalein: 576 (473).

2, 3, 6, 7-Tetrachlorophenolphthalein: 581.5, 303 in alk. H_2O ; 590, 309 in alk. EtOH; 530 in H_2SO_4 (460); cf. (45q, 638q).

3', 4', 5', 6'-Tetrachlorophenolphthalein: 303, 281, 272, 250 in abs. EtOH (178); 575, 362, 278 in alk. H_2O ; 583, 364, 280 in alk. EtOH (288q); cf. (45q, 287, 467, 638q).

$\text{C}_{20}\text{H}_{10}\text{I}_4\text{O}_4$.—2, 3, 6, 7-Tetraiodophenolphthalein: 593.5, 400, 312.5 in alk. H_2O ; 597, 313 in alk. EtOH (288q); cf. (45q, 287, 454, 458).

$\text{C}_{20}\text{H}_{11}\text{Br}_3\text{O}_4$.—2, 3, 6-Tribromophenolphthalein: 577 in alk. H_2O (462); cf. (638q).

3' (4' or 5'), 6'-Tribromophenolphthalein: 576 in alk. H_2O (462).

$\text{C}_{20}\text{H}_{12}\text{Br}_2\text{O}_3$.—2, 3-Dibromophenophenylphthalein: 568 in alk. H_2O (454).

$\text{C}_{20}\text{H}_{12}\text{Br}_2\text{O}_4$.—2, 3-Dibromophenolphthalein: 570 in alk. H_2O (462); 506 in H_2SO_4 (460).

3, 6-Dibromophenolphthalein: 569 in alk. H_2O (462); cf. (638q).

3', 5'-Dibromophenolphthalein: 571 in alk. H_2O (462).

3', 6'-Dibromophenolphthalein: 573 in alk. H_2O (462).

$\text{C}_{20}\text{H}_{12}\text{Br}_2\text{O}_6$.—3, 6-Dibromocatecholophthalein: 720, 489 in alk. H_2O (454).

$\text{C}_{20}\text{H}_{12}\text{Cl}_2\text{O}_4$.—2, 3-Dichlorophenolphthalein: 569 in alk. H_2O ; 505 in H_2SO_4 (460).

2, 7-Dichlorophenolphthalein: 570 in alk. H_2O (460).

4, 5-Dichlorophenolphthalein: 597 in alk. H_2O (454).

$\text{C}_{20}\text{H}_{12}\text{N}_2\text{O}_8$.—3', 5'-Dinitrophenolphthalein: 582 (473).

$\text{C}_{20}\text{H}_{13}\text{BrO}_4$.—Phenol-*p*-bromophenolphthalein: 559 in alk. H_2O (476).

3-Bromophenolphthalein: 561.5 in alk. H_2O (462).

4-Bromophenolphthalein: 567 in alk. H_2O (462).

3'-Bromophenolphthalein: 566 in alk. H_2O (462).

4'-Bromophenolphthalein: 556 in alk. H_2O (462).

5'-Bromophenolphthalein: 561 in alk. H_2O (462).

$\text{C}_{20}\text{H}_{13}\text{ClO}_4$.—1-Chlorophenolphthalein: 564 in alk. H_2O (462).

2-Chlorophenolphthalein: 560 in alk. H_2O ; 502 in H_2SO_4 (460).

3'-Chlorophenolphthalein: 563 in alk. H_2O (462).

$\text{C}_{20}\text{H}_{13}\text{IO}_4$.—1-Iodophenolphthalein: 568.5 in alk. H_2O (462).

$\text{C}_{20}\text{H}_{13}\text{NO}_6$.—3'-Nitrophenolphthalein: 570 in alk. H_2O (467).

4'-Nitrophenolphthalein: 542 (473).

5'-Nitrophenolphthalein: 570 (473); cf. (467).

m-Nitro-*o*, *p'*-phenolphthalein: 588 in alk. H_2O (456).

$\text{C}_{20}\text{H}_{13}\text{O}_4$.—"Bridged phenolphthalein" (in 4, 5 positions): 555 (111).

$\text{C}_{20}\text{H}_{14}\text{O}_2$.—Diphenylphthalide: (283, 276, 269, 259, 253) in EtOH; 446, (408), 305, 253 in concd. H_2SO_4 (490q).

$\text{C}_{20}\text{H}_{14}\text{O}_3$.—Phenylphenolphthalein (*p*-hydroxydiphenylphthalide): 395 in alk. H_2O (464); 262 in EtOH; 470 in H_2SO_4 (442); cf. (470).

$\text{C}_{20}\text{H}_{14}\text{O}_4$.—Isophenolphthalein (*o*, *p'*-phenolphthalein): 285, 277 in EtOH; (500), 449, (426), (286), (260) in H_2SO_4 ; 294, 243 in 33% KOH soln.; 590, 410 in alk. EtOH (487); 552 in alk. soln. (475); cf. (490).

Phenolphthalein: 284, 277 in EtOH; 494, 391, (324, 281, 260) in concd. H_2SO_4 ; 560, (367, 294), 253 in EtOH + KOH; 296, 248 in 33% aq. KOH (490); 552.5, 369, 286 in alk. H_2O ; 562, 364 in alk. EtOH (288q); 570 in alk. Me_2CO (501); cf. (13, 45, 58, 111, 156, 178, 195, 197, 262q, 287, 433q, 439q, 441, 442, 444q, 445, 454, 458, 461, 487, 583q, 638q).

Phenolisophthalein: 560 in alk. H_2O (461).

$C_{20}H_{14}O_4$.—Phenoltterephthalein: 550 in alk. H_2O (461); *cf.* (462).
 Resorcinolphenylphthalein: 498 in H_2SO_4 (454).
 $C_{20}H_{14}O_5$.—3'-Hydroxyphenolphthalein: 556 in H_2O with NaOH; 562 with $NaHCO_3$ (467).
 4'-Hydroxyphenolphthalein: 542 in alk. H_2O ; 481 in H_2SO_4 (454).
 Phenolpyrocatecholphthalein: 579 in alk. H_2O ; 552 in H_2SO_4 (455); *cf.* (550).
 Phenolhydroquinolphthalein (*p*-Hydroxyisophenolphthalein): 498 in alk. H_2O (Moir?).
 $C_{20}H_{14}O_5$.—3', 6'-Dihydroxyphenolphthalein: 549 in H_2O with NaOH; 563 with $NaHCO_3$ (467).
 4', 5'-Dihydroxyphenolphthalein: 558 in H_2O with NaOH; 568 with $NaHCO_3$ (467).
 Pyrocatecholphthalein: alkali salt, 635 in H_2O ; 600 in dil. NaOH soln.; 543.5 in H_2SO_4 (156); *cf.* (197, 454, 550).
 $C_{20}H_{14}O_{10}S_2$.—2, 7-Disulfophenolphthalein: 577 in alk. H_2O (454).
 $C_{20}H_{16}NO_3$.—Phenolanilinephthalein: 558 in alk. H_2O (455).
 $C_{20}H_{16}NO_4$.—*o*-Amino-*o*, *p*'-phenolphthalein: 570 in alk. H_2O (473); (value given in (456) is erroneous).
 $C_{20}H_{16}N_2O_4$.—*o*-Diaminophenolphthalein: 630 in alk. H_2O (454); (value of 610 given in (172) for "diaminophenolphthalein").
 $C_{21}H_{12}Cl_4O_4$.—Tetrachloro-*o*, *p*'-phenol-*m*-cresolphthalein: 590 (473).
 $C_{21}H_{14}Br_2O_4$.—2, 3-Dibromo-6-methylphenolphthalein: 573 in alk. H_2O ; 511 in H_2SO_4 (460).
 2, 3-Dibromo-8-methylphenolphthalein: 584 in alk. H_2O ; 521 in H_2SO_4 (460).
 $C_{21}H_{14}Br_4O_5S$.—2, 3, 6, 7-Tetrabromo-*m*-cresolsulfonphthalein ("Bromeresol Green"): 614 in alk. H_2O ; 619 in alk. EtOH (281q); *cf.* (81q, 433).
 $C_{21}H_{14}Cl_4O_5S$.—2, 3, 6, 7-Tetrachloro-*m*-cresolsulfonphthalein ("Chloreresol Green"): 612 in alk. soln. (81q).
 $C_{21}H_{14}O_5$.—Phenyl-*o*-hydroxybenzoic acid-phthalein (hydroxydiphenylphthalide-*o*-carboxylic acid): 420 in weakly alk. H_2O (464); 471 in H_2SO_4 (470).
 Phenyl-*p*-hydroxybenzoic acid-phthalein: 486 in alk. H_2O (457).
 $C_{21}H_{14}O_6$.—Phenolphthalein-*o*-carboxylic acid: 561 in H_2O with NH_3 ; 567 with NaOH (456).
 Isophenolphthalein-*m*-carboxylic acid: 562 in very weak alkali; 570 in strong alkali; 502 in H_2SO_4 (456).
 $C_{21}H_{15}BrO_4$.—Phenolbromo-*o*-cresolphthalein: 570 in alk. H_2O (476).
 Phenolbromo-*p*-cresolphthalein: 569 in alk. H_2O (476).
 $C_{21}H_{15}IO_4$.—2-Iodo-3-methylphenolphthalein: 576 in alk. H_2O (473).
 Phenol-6-iodo-*o*-cresolphthalein: 576 in alk. H_2O (476).
 $C_{21}H_{16}Br_2O_5S$.—Dibromo-*o*-cresolsulfonphthalein ("Bromeresol Purple"): 591 in alk. H_2O (58q); *cf.* (66q). Ultra-violet abs. (21).
 $C_{21}H_{16}O_3$.—Phenyl-*o*-cresolphthalein: 564 in alk. H_2O (454).
 Phenyl-*m*-cresolphthalein: 506 in H_2SO_4 (457).
 $C_{21}H_{16}O_4$.—Phenol-*o*-cresolphthalein: 562 in alk. H_2O (476); *cf.* (455).
 Phenol-*m*-cresolphthalein: 569 in alk. H_2O ; 526 in H_2SO_4 (457); *cf.* (476).
 Phenol-*p*-cresolphthalein: 563 in alk. H_2O (476); 572 in alk. H_2O ; 487 in H_2SO_4 (456).
 Phenolphthalein methyl ether: 555 in alk. H_2O ; 503 in H_2SO_4 (457).
 Phenolphthalein methyl ester: 560 in alk. H_2O (567 in strong alkali); 523 in H_2SO_4 (458); *cf.* (439).
 $C_{21}H_{16}O_5$.—Phenolguaiacolphthalein: 580 in alk. H_2O ; 525 in H_2SO_4 (455).
 5'-Methoxyphenolphthalein: 565 in alk. H_2O (467).

$C_{21}H_{17}NO_3$.—Phenolmethylanilinephthalein: 576 in alk. H_2O (455).
m-Methylaminoisophenolphthalein: 640 in alk. H_2O (456).
 $C_{21}H_{18}O_5S$.—*o*-Cresolsulfonphthalein ("Cresol Red"): 437, (318), 287 in H_2O ; 525, (426), 406, (320), 276 in abs. EtOH; 509, 381, (284, 265) in concd. H_2SO_4 ; 573, 367, 294 in alk. aq. soln. (178); *cf.* (58q, 66q, 433q).
m-Cresolsulfonphthalein ("Metacresol Purple"): 580 in alk. soln.; 533 in acid soln. (81q).
 $C_{21}H_{18}O_7S$.—Guaiacolsulfonphthalein: 608 in alk. H_2O ; 565 in *N* HCl; 570 in H_2SO_4 (455).
 $C_{22}H_{14}Br_4O_4$.—Tetrabromophenolphthalein ethyl ester (638q).
 $C_{22}H_{14}Cl_4O_4$.—*o*-Cresol-3', 4', 5', 6'-tetrachlorophthalein: 305, 282, 275, 253 in abs. EtOH (178).
 $C_{22}H_{14}O_8$.—*o*-Dicarboxyphenolphthalein: 559 in alk. H_2O (454).
m-Dicarboxyphenolphthalein: 559 in alk. H_2O (454).
 $C_{22}H_{14}O_{10}$.—Protocatechuicphthalein: 612 in alk. H_2O (454).
 $C_{22}H_{16}Br_2O_4$.—*o*-Dibromo-*o*-cresolphthalein: 578 in alk. H_2O ; 530.5 in H_2SO_4 (454).
 $C_{22}H_{16}Br_2O_5$.—Dibromoguaiacolphthalein: 673 in alk. H_2O (454).
 $C_{22}H_{16}O_5$.—*p*-Carboxyisophenolphthalein methyl ether: 558 in alk. H_2O ; 503 in H_2SO_4 (456).
 $C_{22}H_{18}O_4$.—*o*-Cresolphthalein: 569.5 in alk. H_2O ; 577 in alk. EtOH (156); 587 in AmOH (458); 284, 277 in abs. EtOH; 508, 386, (322), 282, (267), 234 in concd. H_2SO_4 (178); *cf.* (195, 197, 454, 476).
m-Cresolphthalein: 576 in alk. H_2O ; 583 in alk. EtOH (156); *cf.* (197, 457, 476).
 Phenolphthalein dimethyl ether: 518 in H_2SO_4 ; 521 in $CHCl_3$ + $SnCl_2$ (314); *cf.* (457).
 Phenol-*asym.*-*o*-xylenolphthalein: 578 in alk. H_2O (476).
 Phenol-*adj.*-*o*-xylenolphthalein: 575 in alk. H_2O (476).
 Phenol-4-hydroxy-*o*-xylenephthalein: 573 in alk. H_2O (473).
 Phenol-*adj.*-*m*-xylenolphthalein: 570 in alk. H_2O (476).
 Phenol-*asym.*-*m*-xylenolphthalein: 573 in alk. H_2O (476); *cf.* (473).
 Phenol-*sym.*-*m*-xylenolphthalein: 572 in alk. H_2O (476).
 Phenol-*p*-xylenolphthalein: 574 in alk. H_2O (476); *cf.* (473).
 $C_{22}H_{18}O_5$.—Phenolhydroquinolphthalein ethyl ether: 552, (490) in alk. H_2O (457).
 $C_{22}H_{18}O_6$.—Guaiacolphthalein: 597 in alk. H_2O ; 602 in alk. EtOH (156); *cf.* (197, 454).
 3', 6'-Dimethoxyphenolphthalein: 568 in alk. H_2O (467).
 4', 5'-Dimethoxyphenolphthalein: 556 in alk. H_2O (467).
 5', 6'-Dimethoxyphenolphthalein: 571 in alk. H_2O (467).
 $C_{22}H_{19}NO_2$.—Phenyldimethylanilinephthalein: 480 in alk. H_2O (464).
 $C_{22}H_{19}NO_3$.—Phenoldimethylanilinephthalein: 587.5 in alk. H_2O (455); 430 in H_2SO_4 (470).
 $C_{22}H_{20}O_5S$.—Hydroxyisopropylphenolsulfonphthalein: 598 in alk. H_2O ; 507 in acid H_2O (271).
 $C_{23}H_{14}O_5$.—Phenolecoumarinphthalein: 565 in alk. H_2O (455).
 $C_{23}H_{15}NO_7S$.—Phenolquinosolphthalein: 598 in alk. H_2O ; 520 in H_2SO_4 (455).
 $C_{23}H_{20}O_4$.—Phenolpseudocumenolphthalein: 581 in alk. H_2O (476).
 $C_{23}H_{22}O_5S$.—Phenolsulfonphthalein diethyl ether: (509, 402, 310, 282, 275, 268) in EtOH (178).
 $C_{23}H_{24}N_2O_3S$.—*bis*-Dimethylanilinesulfonphthalein: 593 in H_2O ; 634 in acid H_2O (461).
 $C_{24}H_{12}Cl_4O_4$.—Tetrachloro-*o*, *p*-phenol- α -naphtholphthalein: 630 (473).
 $C_{24}H_{16}O_3$.—Phenyl- α -naphtholphthalein: (454, 467).
 $C_{24}H_{16}O_4$.—*p*, *o*'-Phenol- α -naphtholphthalein: 612 in alk. H_2O (476); *cf.* (455).

$C_{24}H_{16}O_4$.—*p*, *p'*-Phenol- α -naphtholphthalein: 601 in NH_4OH soln.; 587 in coned. H_2SO_4 (473); *cf.* (476).

Phenol- β -naphtholphthalein: 570 in alk. H_2O (476); *cf.* (467).

$C_{24}H_{16}O_5$.—Resoreinol- α -naphtholphthalein: 468 in alk. H_2O (197).

$C_{24}H_{17}NO_3$.—Phenol- α -naphthylaminephthalein: 740 in alk. H_2O (455).

$C_{24}H_{18}Cl_4O_4$.—Tetrachloro-*o*, *p'*-phenolphthymolphthalein: 597 (473).

p-Xylenoltetrachlorophthalein: 625 (473).

$C_{24}H_{18}O_8$.—Methyl salicylate phthalein: 557 in alk. H_2O (454).

$C_{24}H_{20}O_4$.—Phenoltetrahydro- α -naphtholphthalein: 584 in alk. H_2O (476); 530 in H_2SO_4 (455).

$C_{24}H_{22}O_4$.—Phenolearvaerolphthalein: 580 in alk. H_2O (455); *cf.* (476).

Phenolphthymolphthalein: 578 in alk. H_2O ; 520 in H_2SO_4 (455); *cf.* (476).

$C_{24}H_{22}O_4$.—*vic. o*-Xylenolphthalein: 593 in alk. H_2O (476).

vic. m-Xylenolphthalein: 581 in alk. H_2O (476).

p-Xylenolphthalein: 590 in alk. H_2O (476); *cf.* (473).

$C_{24}H_{22}O_6$.—3', 6'-Dimethoxy-*o*-eresolphthalein: 580 in alk. soln. (195).

3, 6'-Dimethoxy-*m*-eresolphthalein: 585 in alk. soln. (195).

$C_{24}H_{28}O_4$.—Phenolmentholphthalein: 563 in alk. H_2O (455).

$C_{25}H_{18}O_4$.— α -Naphtholmethyl ether phenolphthalein: 470 in alk. soln.; 572 in coned. H_2SO_4 (473).

$C_{25}H_{24}O_4$.—Thymol-*m*-eresolphthalein: 590 in alk. H_2O ; 530 in H_2SO_4 (457).

Thymol-*p*-eresolphthalein: 595 in alk. H_2O (457).

$C_{25}H_{26}O_5S$.—*o*-Cresolsulfonphthalein diethyl ether: 525, (394, 318). (284, 275, 269), 237 in EtOH (178).

$C_{26}H_{18}O_6$.—Phenolnaphthoxyacetic acid phthalein: 485 in slightly alk. soln.; 592 in coned. H_2SO_4 (473).

$C_{26}H_{19}NO_3$.—Phenoldiphenylaminephthalein: 565 in alk. H_2O (456).

$C_{26}H_{21}NO_3$.—Phenoldimethyl- α -naphthylaminephthalein: 625 in alk. soln. (467).

$C_{26}H_{26}O_4$.—*p*-Ethoxyphenolphthymolphthalein: 598 in alk. H_2O (457).

$C_{27}H_{18}O_5S$.— α -Naphtholsulfonphthalein: 730 in alk. H_2O ; 720, 500 in H_2SO_4 (455).

$C_{27}H_{23}Br_2O_5S$.—Dibromothymolsulfonphthalein ("Bromthymol Blue"): 617 in alk. H_2O (58q); ultra-violet abs. (21); *cf.* (66q, 433q).

$C_{27}H_{30}O_5S$.—Carvaerolsulfonphthalein: 593 in alk. H_2O , 603 in alk. EtOH (677).

Thymolsulfonphthalein ("Thymol Blue"): 596 in alk. H_2O ; 544 in acid H_2O (58q); 570 in H_2SO_4 (455); *cf.* (280q, 433q).

$C_{28}H_{14}Br_4O_4$.— α -Naphtholtetrabromophthalein: 678 in alk. H_2O ; 654 in H_2SO_4 (454).

$C_{28}H_{17}NO_6$.—3'-Nitro- α -naphtholphthalein: 730 in alk. H_2O (455).

$C_{28}H_{18}O_4$.—*o*, *o'*- α -Naphtholphthalein: 671 in alk. H_2O ; about 625 in coned. H_2SO_4 (473).

p, *p'*- α -Naphtholphthalein: 650 in alk. H_2O (476); *cf.* (156, 197, 454, 458, 66q).

Phenol- α -anthrophthalein: 628 in alk. H_2O ; 611 in H_2SO_4 (457).

Phenol- β -anthrophthalein: 730 in alk. H_2O (457).

$C_{28}H_{18}O_5$.—3'-Hydroxy- α -naphtholphthalein: 622 in alk. H_2O (454).

$C_{28}H_{24}O_4$.—Thymol- α -naphtholphthalein: 633 in alk. H_2O (457).

Thymol- β -naphtholphthalein: 700 in alk. H_2O (457).

$C_{28}H_{26}Br_4O_4$.—Thymoltetrabromophthalein: 623 in alk. H_2O ; 575 in H_2SO_4 (454).

$C_{28}H_{26}O_4$.—Tetrahydronaphtholphthalein: 602 in alk. H_2O (454).

$C_{28}H_{25}Br_2O_4$.—Dibromoearvaerolphthalein: 623 in alk. H_2O (454).

Dibromothymolphthalein: 625 in alk. H_2O (454).

$C_{28}H_{29}NO_6$.—3'-Nitrothymolphthalein: 602 in alk. H_2O (455).

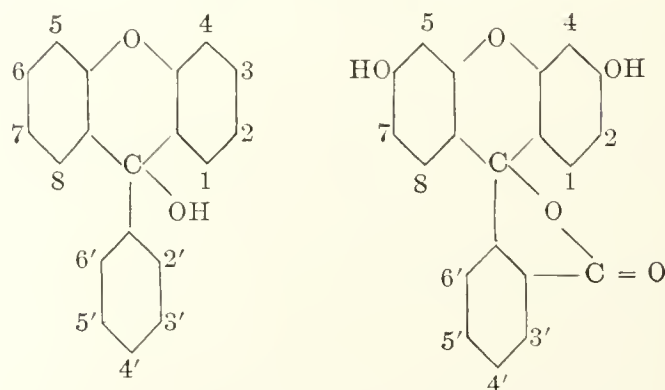
$C_{28}H_{30}O_4$.—Carvaerolphthalein: 602 in alk. H_2O (156); 554 in H_2SO_4 (454); *cf.* (197, 476).

Thymolphthalein: 596.5 in alk. H_2O ; 603 in alk. EtOH (156); 548 in H_2SO_4 (454); ultra-violet band at 398 in alk. H_2O (458); *cf.* (58q, 197, 476).

$C_{32}H_{26}O_4$.—Thymol- α -anthrophthalein: "probably" 710 in alk. H_2O ; 636 in H_2SO_4 (457).

$C_{36}H_{22}O_4$.— α -Anthrophthalein: 740 in alk. H_2O ; 720 in H_2SO_4 (457).

TABLE 5.—XANTHENE DYES



$C_{13}H_8O_2$.—Xanthone: 333, 282 (also gives data on xanthene) (608); 405, 340 in H_2SO_4 (470).

$C_{13}H_8O_3$.—3-Hydroxyfluorone: 504 in EtOH + HCl (644).

$C_{13}H_8O_4$.—3, 6-Dihydroxyxanthone: 381 in EtOH + HCl (644).

$C_{13}H_{10}O_2$.—Xanthidrol: 450 in H_2O (470).

$C_{13}H_{10}O_4$.—3, 6-Dihydroxyxanthidrol: 479 in H_2O (465).

$(C_{15}H_{15}N_2O)_2SO_4$.—*sym.*-Dimethyldiaminoxanthenyl sulfate: 583 in EtOH (44q).

$C_{17}H_{18}N_2O_2$.—3, 6-Tetramethyldiaminoxanthone: 386.1 in EtOH + HCl (644).

$C_{17}H_{19}N_2O(Cl)$.—Tetramethyldiaminoxanthenyl ehloride (Pyronine G, C. I. 739): 547.5, 505.6 in H_2O ; 547.9, 511.2 in EtOH; 548.3, 512.8 in AmOH (155); 507 in H_2O (eoned.), 545 (dil.) (677); *cf.* (111, 465, 644). Cyanpyronine G; 663, 603, (280, 270) in EtOH (221).

$C_{19}H_8Br_4O_6S$.—Tetrabromoresoreinolsulfonphthalein: 527 in alk. H_2O (466).

$C_{19}H_9Br_4NO_6$.—2, 4, 5, 7-Tetrabromo-4'-nitroresoreinolbenzein: 527 in alk. H_2O (466).

$C_{19}H_{10}Br_2O_6S$.—Dibromosulfonfluoreseein: (497.5), 462, (393, 307, 283, 269), 262, 241 in abs. EtOH; 450, (354, 340, 327, 304), 269, (261, 234) in coned. H_2SO_4 (177q). Diaetate: (497), 464, (447), 359, (303), 272, 265, 237 in abs. EtOH (177q).

$C_{19}H_{10}Br_4O_4$.—2, 4, 5, 7-Tetrabromoresoreinolbenzein: 519 in alk. H_2O (466).

$C_{19}H_{11}NO_8S$.—4'-Nitroresoreinolsulfonphthalein: 506 in alk. H_2O (466).

$C_{19}H_{12}O_6S$.—Sulfonfluoreseein: (488), 446, (315, 300, 264, 252), 230 in abs. EtOH; 439, (333, 316, 291), 257, (252, 225) in coned. H_2SO_4 ; 502.5, (475, 379, 321, 293, 260), 243 in EtOH + KOH; diaetate, (482), 444, (411, 293), 259 in abs. EtOH; dichloride, 309, 299, 266 in abs. EtOH (177q); Moir reports bands at (522), 497 in alk. H_2O and at 576 in $N HCl$ for resorcinolsulfonphthalein (455).

$C_{19}H_{12}O_6S$.—Hydroquinolsulfonphthalein: (510), 443, 366, 284, (242) in EtOH; (500), 432, 365, 280, (241) in H_2O ; (488), 403, 370, 274, (241) in concd. H_2SO_4 ; 542, 375, 315, 249 in EtOH + KOH; 461, 325, 250 in 33% aq. KOH; dibenzoate, (458), 388, (302), 269, 227 in EtOH (584q).

$C_{19}H_{13}BrO_4$.—3'-Bromoresorcinolbenzein: 497 in alk. H_2O (466).

4'-Bromoresorcinolbenzein: 493 in alk. H_2O (466).

6'-Bromoresorcinolbenzein: 505 in alk. H_2O (466).

$C_{19}H_{13}BrO_5$.—3'-Bromo-4'-hydroxyresorcinolbenzein: 490 in H_2O (550 with alkali) (466).

$C_{19}H_{13}NO_5S$.—Resorcinolsaceharein: "spectrum identical with fluorescein" (455).

$C_{19}H_{13}NO_5$.—4'-Nitroresorcinolbenzein: 500 in alk. H_2O (466).

$C_{19}H_{14}O_4$.—Resorcinolbenzein: 490, 459, (433, 370, 317, 312, 276, 270, 253) in EtOH; 446, (348, 295, 262, 251) in EtOH + HCl; 426, (370, 282), 256, 251 in concd. H_2SO_4 ; 505, (475, 379), 324, 292, (259), 242 in EtOH + KOH; 492, (384), 327, 285, (256), 239 in 5% aq. KOH (493q); 501 in alk. H_2O ; 442 in H_2SO_4 (454); 508 in EtOH (514, 478) with alkali (429).

$C_{19}H_{14}O_5$.—3'-Hydroxyresorcinolbenzein: 494 in H_2O (492 with alkali) (466).

4'-Hydroxyresorcinolbenzein: 484 in H_2O ; 492 in slightly alk. soln.; 544 with excess alkali (466).

6'-Hydroxyresorcinolbenzein: 492, 430 in H_2O (466).

$C_{19}H_{14}O_6$.—Hydroxyquinolbenzein: 500 in EtOH (523 with alkali) (429).

Pyrogallolbenzein: 496 in EtOH (535 with alkali) (429).

$C_{20}H_2I_{10}O_5$.—Dekaiodofluorescein: K salt, 549.5 in alk. H_2O ; 556.5 in alk. EtOH (272).

$C_{20}H_4Br_3Cl_4IO_5$.—4, 5, 7-Tribromo-3', 4', 5', 6'-tetrachloro-2-iodofluorescein: 543 in alk. H_2O (466).

$C_{20}H_4Br_4Cl_4O_3$.—Tetrabromotetrachlorofluoran: 311 in EtOH (287).

$C_{20}H_4Br_4Cl_4O_5$.—2, 4, 5, 7-Tetrabromo-3', 4', 5', 6'-tetrachlorofluorescein (C. I. 778): K salt, 537.3, 498.5 in H_2O ; 549.9, 509.5 in EtOH; 474.5 in H_2SO_4 (155); ultra-violet band at 307 in H_2O (352); cf. (272, 287, 466, 637); also (?) (3, 162q, 299, 497, 642).

$C_{20}H_4Br_4I_4O_5$.—2, 4, 5, 7-Tetrabromo-3', 4', 5', 6'-tetraiodofluorescein: 540 in alk. H_2O ; 551 in alk. EtOH (272).

3', 4', 5', 6'-Tetrabromo-2, 4, 5, 7-tetraiodofluorescein: 548 in alk. H_2O ; 560 in alk. EtOH (637).

$C_{20}H_4Br_8O_5$.—Octabromofluorescein: 539 in alk. H_2O ; 550 in alk. EtOH (272); 553 in 0.1% HOAc; 520 in solid form (677); cf. (456, 637).

$C_{20}H_4Cl_4I_4O_5$.—3', 4', 5', 6'-Tetrachloro-2, 4, 5, 7-tetraiodofluorescein (C. I. 779): Na salt, 547.7, 507.3 in H_2O ; 558.1, 516.1 in EtOH; 490.5 in H_2SO_4 (155); 560 on wool (642); cf. (3, 162, 272, 466, 637).

$C_{20}H_4Cl_8O_5$.—Octachlorofluorescein: 537 in alk. H_2O (466).

$C_{20}H_4I_8O_5$.—Octaiodofluorescein: 550 in alk. H_2O ; 558 in alk. EtOH (272).

$C_{20}H_5Br_4Cl_3O_5$.—2, 4, 5, 7-Tetrabromo-3', 4', 5'-trichlorofluorescein: 536 in alk. H_2O (466).

$C_{20}H_5Br_7O_5$.—2, 4, 5, 7, 3', 5', 6'-Heptabromofluorescein: 540 in alk. H_2O (466).

$C_{20}H_5Br_4Cl_2O_3S_2$.—2, 4, 5, 7-Tetrabromo-3', 6'-dichlorothiofluorescein: 520.5 in H_2O + NH_3 ; 526.5 in EtOH + NH_3 (637).

$C_{20}H_5Br_4Cl_2O_5$.—2, 4, 5, 7-Tetrabromo-3', 5'-dichlorofluorescein: 538 in alk. H_2O (466).

2, 4, 5, 7-Tetrabromo-3', 6'-dichlorofluorescein (C. I. 774): K salt, 529.4, 492 in H_2O ; 541.1, 501.5 in EtOH; 466 in H_2SO_4 (155); 531.5 in alk. H_2O ; 546.5 in alk. EtOH (637); 545 on wool (642); ultra-violet band at 305 in H_2O (352); cf. (676q).

2, 4, 5, 7-Tetrabromo-4', 5'-dichlorofluorescein: 529 in alk. H_2O (466).

$C_{20}H_6Br_6O_5$.—2, 4, 5, 7, 3', 5'-Hexabromofluorescein: 535 in alk. H_2O (466).

2, 4, 5, 7, 3', 6'-Hexabromofluorescein: 539 in alk. H_2O (466); (538) (465).

$C_{20}H_6Cl_2I_4O_3S_2$.—2, 4, 5, 7-Tetraiodo-3', 6'-dichlorothiofluorescein: 560 in H_2O + NH_3 ; 565 in EtOH + NH_3 (637).

$C_{20}H_6Cl_2I_4O_5$.—2, 4, 5, 7-Tetraiodo-3', 6'-dichlorofluorescein (C. I. 777): Na salt, 538.1, 499.5 in H_2O ; 548.7, 508 in EtOH; 483 in H_2SO_4 (155); 540 in alk. H_2O ; 556.5 in alk. EtOH (637); ultra-violet band at 310 (352); infra-red abs., 8, (1.3), 3.5, 5.4, 6.4, 7.0, 7.6, 9.1, (9.9), 10.3, 11.0 μ (296); 560 on wool (642); cf. (388q, 390q, 391, 418q, 518q).

$C_{20}H_7Br_4NO_7$.—2, 4, 5, 7-Tetrabromo-3'-nitrofluorescein: 530 in alk. H_2O (466).

2, 4, 5, 7-Tetrabromo-5'-nitrofluorescein: 529 in alk. H_2O (466).

$C_{20}H_7Br_5O_5$.—2, 4, 5, 7, 3'-Pentabromofluorescein: 529 in alk. H_2O (466).

2, 4, 5, 7, 5'-Pentabromofluorescein: 526 in alk. H_2O (466).

$C_{20}H_7Cl_4IO_5$.—3', 4', 5', 6'-Tetrachloro-2-iodofluorescein: 520 in alk. H_2O (466).

$C_{20}H_8Br_2N_2O_9$.—2, 7-Dibromo-4, 5-dinitrofluorescein: 522 in alk. H_2O (466).

4, 5-Dibromo-2, 7-dinitrofluorescein (C. I. 771): 535 on wool; 530 in gelatin (transmission); 541 (reflection) (642); 519 in H_2O ; 530 in solid form (677); cf. (162q, 497).

$C_{20}H_8Br_4O_5$.—2, 4, 5, 7-Tetrabromofluorescein (Na salt, Eosin, C. I. 768): 516, 482.5 in H_2O ; 527.6, 489.2 in EtOH; 545 in H_2SO_4 (155); 523 in alk. EtOH (272); 285 in slightly acid EtOH (287); 510 on wool (642); 533 in 1% HOAc; 520 in solid form (677); infra-red abs., 0.7, 6.9, (8.4), 9.2, 10.2 μ (296); ultra-violet bands in H_2O at 344, 303 (352); cf. (335, 418); influence of temp., (57, 426); cf. (3, 114, 162q, 272, 299, 332, 390q, 391q, 445q, 447, 454, 497, 637).

3', 4', 5', 6'-Tetrabromofluorescein: 510 in alk. H_2O ; 521 in alk. EtOH (272); 438.5 in H_2SO_4 (454); 515, 478 in solid form (677); cf. (466, 637).

$C_{20}H_8Cl_4O_3$.—3', 4', 5', 6'-Tetrachlorofluoran: 309, 295 in EtOH (286).

$C_{20}H_8Cl_4O_5$.—2, 4, 5, 7-Tetrachlorofluorescein: 518 in alk. H_2O (466); (519) (460).

3', 4', 5', 6'-Tetrachlorofluorescein: 500.5 in alk. H_2O ; 520 in alk. EtOH (272); ultra-violet abs. (287); cf. (466, 637).

$C_{20}H_8Cl_4O_7$.—3', 4', 5', 6'-Tetrachlorohydroxyhydroquinolphthalein: 577, 530 in alk. H_2O (466).

$C_{20}H_8I_4O_5$.—2, 4, 5, 7-Tetraiodofluorescein (Na salt, Erythrosin, C. I. 773): 526, 351, 309, 260 in H_2O (179q); in EtOH, disodium salt, 531; monosodium salt, 541; dye acid, 490 (279); 467.5 in H_2SO_4 (155); 537.5 on wool (642); 542 on silk (627); cf. (10); influence of temp. (334q, 335q); infra-red abs. (0.9), 1.9, 3.1, 4.5, 6.4, 6.9, 7.4, 8.1, 9.5, 10.2, 10.8, (11.4) μ (296); cf. (114q, 272, 454, 628, 629, 637).

3', 4', 5', 6'-Tetraiodofluorescein: 511 in alk. H_2O ; 522 in alk. EtOH (272); 532, 500 in solid form (677).

$C_{20}H_8N_4O_{13}$.—2, 4, 5, 7-Tetranitrofluorescein: 489 in H_2O ; 523.8 in EtOH (500.4 with alkali) (350).

$C_{20}H_9Br_3O_5$.—2, 4, 7-Tribromofluorescein: 515 in alk. H_2O (466).

3', 5' (or 4'), 6'-Tribromofluorescein: 511 in alk. H_2O (466).

$C_{20}H_9Cl_3O_5$.—3', 4', 5'-Trichlorofluorescein: 505 in alk. H_2O (466).

$C_{20}H_{10}Br_2O_5$.—2, 7-Dibromofluorescein: 509 in alk. H_2O (466); 598 (460).

4, 5-Dibromofluorescein: 505 in alk. H_2O ; 510 in alk. EtOH (272); 520, 490 in solid form (677); cf. (155, 637).

$C_{20}H_{10}Br_2O_3$.—3', 5'-Dibromofluorescein: 506 in alk. H_2O (466).
3', 6'-Dibromofluorescein: 509 in alk. H_2O (466).
 $C_{20}H_{10}Cl_2O_3$.—4, 4'-Dichlorofluoran: 295, 284, 275, 265 in abs. EtOH (494q).
 $C_{20}H_{10}Cl_2O_3S_2$.—3', 6'-Dichlorothiofluorescein: 530, 503 in $H_2O + NH_3$ (637).
 $C_{20}H_{10}Cl_2O_5$.—3', 6'-Dichlorofluorescein: 505 in alk. H_2O ; 517.5 in alk. EtOH (637).
 $C_{20}H_{10}I_2O_5$.—4, 5-Diiodofluorescein (Na salt, C. I. 772): 507 in alk. H_2O ; 518 in alk. EtOH (637); 510.8 in H_2O (155).
 $C_{20}H_{10}N_2O_9$.—4, 5-Dinitrofluorescein: salts (497).
 $C_{20}H_{10}O_5S_2$.—Fluorescein disulfide: 509 in EtOH; 489.2 in alk. H_2O (395).
 $C_{20}H_{11}BrO_5$.—3'-Bromofluorescein: 501 in alk. H_2O (466).
5'-Bromofluorescein: 499 in alk. H_2O (466).
 $C_{20}H_{11}NO_7$.—3'-Nitrofluorescein: 500 in alk. H_2O (466).
5'-Nitrofluorescein: 498 in alk. H_2O (466).
 $C_{20}H_{12}O_3$.—Fluoran: 293, 284, 278, 262 in abs. EtOH; (468, 447, 427), 378, (362, 277), 259, (253) in concd. H_2SO_4 (494q); cf. (287, 442, 454, 470, 473).
 $C_{20}H_{12}O_3S_2$.—Thiofluorescein: 586 in alk. H_2O (172).
 $C_{20}H_{12}O_5$.—Fluorescein (Na salt, C. I. 766): 482, 455, (431, 374, 289, 283), 277 in EtOH; 443, (309, 298, 264, 249) in EtOH + HCl; 432, (329, 311, 290, 256), 250 in concd. H_2SO_4 (494q); Na salt, 489.3, 457.2 in H_2O ; 498.5, 465.7 in EtOH (155); 470 on wool (642); 500, 470 in solid form (677); influence of temp. (57); influence of pH (272); infra-red abs., 0.8, (1.3), 3.5, 5.4, 6.4, 7.0, 7.6, 9.1 (9.9), 10.3, 11.0 μ (296); cf. (3, 111, 114, 156, 287, 351q, 395, 418q, 429, 441, 444, 445, 447q, 454, 466, 470, 497, 603, 666q). Diacetate, 291, 282, 273, 262 in abs. EtOH (494q); *o*-toluidide, 533; *p*-toluidide, 557 (396); anilide, 555 (396).
Hydroquinolphthalein: (517), 443, 363, 283, (245) in EtOH + HCl; (484), 396, 366, 271, (240) in concd. H_2SO_4 ; (526), 346, 261 in EtOH + KOH; 332, 247 in 33% aq. KOH (584q); 497.5 in H_2SO_4 (454); alkali salt: 494 in H_2O (466); 614, 506, 367 (441); 498 in alk. H_2O (454); 516.4, (502), 486.5, 456 in EtOH (156); cf. (287, 444q, 445). Dibenzoate: (299, 282, 272, 232) in EtOH (584q).
 $C_{20}H_{12}O_6$.—3'-Hydroxyfluorescein: 489 in H_2O (494 with alkali) (466); 420 in H_2SO_4 (454).
4'- (or 5'-) Hydroxyfluorescein: 492 in H_2O (466).
o-Hydroxyfluorescein: 523, 498 (473, 550).
 $C_{20}H_{12}O_7$.—1, 8-Dihydroxyfluorescein (Phloroglucinolphthalein): 489 in H_2O (466); 460 in H_2O (156); 496 in alk. H_2O (197); 500 in alk. EtOH (463 with excess alkali) (156); 433 in H_2SO_4 (454).
2, 7-Dihydroxyfluorescein (Hydroxyhydroquinolphthalein): 550, 527, 509 in alk. H_2O (466); 494.5, 462 in EtOH; 554.5, 503 in alk. EtOH; 580.5 with Zn salt (156); cf. (197, 429, 550).
4, 5-Dihydroxyfluorescein (Gallein): 505 in slightly alk. H_2O ; 540 with excess alkali (156); 561.8 in dil. NaOH + NaSH (395); 495 in EtOH (505 with alkali) (429); 522.1 in EtOH with HCl and $SnCl_2$ (395); 461 in H_2SO_4 (454).
3', 6'-Dihydroxyfluorescein: 493 (466).
 $C_{20}H_{12}O_5S_2$.—Thiogallein: 526.2 in EtOH with HCl and $SnCl_2$; 582.3 in EtOH with NaOH and NaSH (395).
 $C_{20}H_{15}N_2O_3(Cl)$.—Rhodamine chloride: 494, 461.4 in H_2O ; 500, 468 in EtOH (155).
 $C_{20}H_{16}O_5$.—4'-Methoxyresorcinolbenzein: 493 in alk. H_2O (466).
6'-Methoxyresorcinolbenzein: 492, 430 in alk. H_2O (466).
 $C_{21}H_8Br_4Cl_2O_5$.—Phloxine methyl ester (K salt, C. I. 776): abs. in various solvents (3).
 $C_{21}H_{10}Br_4O_5$.—Eosin methyl ester (K salt, C. I. 769): in H_2O , 517 at 20°, 519 at 80°; in EtOH, 529.9 at 20°, 531.4 at 70°; in $CHCl_3$, 538.2 at 20°, 539.3 at 60° (664).
 $C_{21}H_{14}O_2$.— β , β -Dinaphthoxanthidrol: 508, 484 (473).

$C_{21}H_{14}O_6$.—3'-Methoxyfluorescein: 497 in alk. H_2O (466).
4'- (or 5') Methoxyfluorescein: 492 in alk. H_2O (466).
 $C_{21}H_{15}O_2$.—*o*-Cresolbenzein: 437, (347, 285), 278 in EtOH; 515, 406, (297), 274 in EtOH + HCl; 581, 385, 300, (250) in EtOH + KOH; 488, 412, (297, 280), 261 in concd. H_2SO_4 ; 356, (296), 251 in concd. aq. KOH (495q).
 $C_{21}H_{27}N_2O(Cl)$.—Tetraethyldiaminoxanthenyl chloride (C. I. 741): 553.9, 514.4 in H_2O ; 553.7, 513.3 in EtOH; 553.7, 513.3 in AmOH (155).
 $C_{22}H_8Br_4Cl_4O_5$.—2, 4, 5, 7-Tetrabromo-3', 4', 5', 6'-tetrachloro- γ -orcinolphthalein: 555, (520) in alk. EtOH (486).
 $C_{22}H_{12}Br_4O_5$.—Eosin ethyl ester (K salt, C. I. 770): 536.7 at 20°, 538.4 at 70° in EtOH (57).
2, 4, 5, 7-Tetrabromo- α -orcinolphthalein: 572 in alk. H_2O (486).
2, 4, 5, 7-Tetrabromo- β -orcinolphthalein: 576 in alk. EtOH (486); 307 in EtOH (287).
2, 4, 5, 7-Tetrabromo- γ -orcinolphthalein: 521 in alk. H_2O (466); 529 in alk. EtOH (486).
 $C_{22}H_{12}Cl_4O_5$.—3', 4', 5', 6'-Tetrachloro- α -orcinolphthalein: 562 in alk. H_2O (486).
3', 4', 5', 6'-Tetrachloro- β -orcinolphthalein: 294 in EtOH (287); 554 in alk. EtOH (486).
3', 4', 5', 6'-Tetrachloro- γ -orcinolphthalein: 511.5 in alk. H_2O (466); 521 in alk. EtOH (486).
 $C_{22}H_{13}Br_3O_5$.—Tribromo- β -orcinolphthalein: 463 in alk. H_2O (466).
 $C_{22}H_{14}Br_2O_5$.—4, 5-Dibromo-2, 7-dimethylfluorescein: 516 in alk. H_2O (466).
 $C_{22}H_{16}O_5$.—2, 7-Dimethylfluorescein (Cresorcin): 500 in alk. H_2O (466).
 α -Orcinolphthalein: 528 in alk. H_2O (486); cf. (197, 466).
 β -Orcinolphthalein: 536 in alk. H_2O (486); cf. (156); 440 (466); 281 (287); 546 in alk. EtOH (156).
 γ -Orcinolphthalein: 490.5, 453 in alk. H_2O (156); 500.5, 461 in alk. EtOH (156); cf. (466, 486).
 $C_{22}H_{16}O_7$.—3', 6'-Dimethoxyfluorescein: 499 in alk. H_2O (466).
4', 5'-Dimethoxyfluorescein: 496 in alk. H_2O (466).
 $C_{22}H_{18}N_2O_3(Cl)$.—*asym.*-Dimethylrhodamine chloride: 524, 488.5 in H_2O ; 526.7, 489.2 in EtOH (519.5, 489.2 after standing) (155).
 $C_{23}H_{18}O_8$.—3', 4', 5'-Trimethoxyfluorescein: 499 in alk. H_2O (466).
 $C_{23}H_{20}NO_3(Cl)$.—Aporrhodamine chloride: 530.7, 491.3, 459 in EtOH (155).
 $C_{23}H_{23}N_2O(Cl)$.—Tetramethylrosamine chloride: 548.7, 511.2 in H_2O ; 551.9, 515.1 in EtOH (155); 555, 393, 360 in EtOH (44).
 $C_{24}H_{20}O_3$.—Tetramethylfluoran: 480, 505 in concd. H_2SO_4 (476).
 $C_{24}H_{20}O_5$.—3', 6'-Dimethoxy-2, 7-dimethylfluoran: 585 in alk. soln. (195).
 $C_{24}H_{23}N_2O_3(Cl)$.—Tetramethylrhodamine chloride: 546.7, 509 in H_2O ; 539.5, 505.6 in EtOH (538.1, 501.6 after standing) (155).
sym.-Diethylrhodamine chloride: 519.3, 487 in H_2O ; 516.3, 483.7 in EtOH (155).
asym.-Diethylrhodamine chloride: 527.4, 490.5 in H_2O , 527.4, 490.5 in EtOH (523.6, 490 after standing) (155).
 $C_{25}H_{25}N_2O_3(Cl)$.—*asym.*-Diethylhomorhodamine chloride: 530.6, 496.2 in H_2O ; 527.3, 492.7 in EtOH (155).
asym.-Dimethylhomorhodamine chloride ethyl ester (C. I. 753): 533.7, 497.3 in H_2O ; 531.3, 494.8 in EtOH (155).
 $C_{26}H_{27}N_2O_3(Cl)$.—*sym.*-Diethylrhodamine chloride ethyl ester (C. I. 752): 521.9, 486.4 in H_2O ; 524.7, 489.2 in H_2SO_4 (155); influence of concn. (269); in various solvents (3); in solid form (548); 530 on wool (642).
Triethylrhodamine chloride (C. I. 750): 353 in H_2O (352); 540 on wool (642).

$C_{27}H_{18}O_2$.—*C*-Phenyl- β , β -dinaphthoxanthidrol: 495, 470 (473).
 $C_{27}H_{19}NO_4$.—Tetraethylrosamine chloride: 563.5, 527.5 in H_2O (523).
 $C_{28}H_{10}Br_4O_7$.—2, 4, 5, 7-Tetrabromoanthraquinonefluorescein: NH_4 salt, 533 in H_2O ; 539, 500 in EtOH (649).
 $C_{28}H_{12}Br_2O_7$.—4, 5-Dibromoanthraquinonefluorescein: NH_4 salt, 519 in H_2O ; 525, 491 in EtOH (649).
 $C_{28}H_{14}O_7$.—Anthraquinonefluorescein: NH_4 salt, 506 in H_2O ; 512, 484 in H_2O (649).
 $C_{28}H_{16}O_8$.— α -Naphthofluoran: 500, 475 in H_2SO_4 (467); 496, 470 in H_2SO_4 (473).
 $C_{28}H_{16}O_8$.— α -Naphthofluorescein: 536.2, 496 in alk. H_2O ; 489.5, 525, 459.5 in EtOH (541.5, 501 with alkali) (156); cf. (466).
 $C_{28}H_{31}N_2O_3(Cl)$.—Tetraethylrhodamine chloride (Rhodamine B, C. I. 749): 552.6, 514.6 in H_2O ; 545.5, 509.6 in EtOH (543.5, 505.6 after standing) (155); infra-red abs., 0.8, (2.0), 3.0, 6.4, 7.3, 8.6, 8.9, (9.6), (11.0) μ (296); influence of concn. (269); dyeings (627, 642); cf. (3, 481, 519q, 666q, 676). Base: 545 in EtOH; 548 with band in the far violet in C_6H_6 (677).
 $C_{30}H_{35}N_2O_3(Cl)$.—Tetraethylrhodamine chloride ethyl ester (C. I. 751): 555.5, 516.3 in H_2O ; 551.9, 512.8 in EtOH (155); 560, 525 on wool (522).
 $C_{32}H_{22}N_2O_6S$.—Sulfodiphenyldiamino-*o*-carboxyphenylxanthenyl (Na salt, Violamine B, C. I. 757): 535 in H_2O (concd.); 545 (dil.) (269); 555 on wool (642).
 $C_{34}H_{16}O_{10}$.—Difluorescein: 495 (111).
 $C_{34}H_{26}N_2O_6S$.—Sulfodi-*o*-tolylldiamino-*o*-carboxyphenylxanthenyl (Na salt, Violamine R, C. I. 758): 361, 306 in H_2O (352); 540 on wool (642); influence of concn. (269).
 $C_{34}H_{34}N_2O(Cl)$.—Acridylpyronine B: 580, 534.8 in H_2O (523).
 $C_{34}H_{36}N_4O_2(Cl)_2$.—Dipyronine G: (668), 538 (111).
 $C_{36}H_{34}N_2O_6S$.—Sulfodimesityldiamino-*o*-carboxyphenylxanthenyl (Violamine G, C. I. 759): 522.5 in H_2O ; 535 on wool (642).

TABLE 6.—QUINOLINE DYES

NOTE.—The 2, 2'-linkage is denoted by the term "pseudocyanine." When employed without further qualification the term "carbocyanine" also implies the 2, 2'-linkage.

$C_{13}H_{15}N_2$.—Dimethylprotocyanine (1, 1'-dimethyl-2-pyridylmethane): 428, 405 in H_2O (472).
 $C_{17}H_{17}N_2$.—Dimethylmesocyanine: 495, 465, 430 in H_2O (472).
 $C_{17}H_{19}N_2S(I)$.—2, 1'-Diethylthio-(pseudo)-pyridocyanine iodide: two poorly defined bands between 460 and 400 (449).
 $C_{18}H_{11}NO_2$.—Quinoline yellow (C. I. 800): on wool (10); 440 in 50% EtOH; isopropyl deriv. and sulfonates (513).
 $C_{19}H_{14}N_2$.—Di-(quinolyl-2)-methane: base, 508, 479, 453 in EtOH (554).
 $C_{19}H_{17}N_2O_2(I)$.—2, 2'-Dimethyloxacarbocyanine iodide (Oxazole Yellow): 485, 456 in EtOH (346); (485, 460) (206).
 $C_{19}H_{17}N_2S(I)$.—1, 2'-Dimethylthiopseudocyanine iodide: 485, (460) (207).
 $C_{19}H_{17}N_2S_2(Br)$.—1, 1'-Dimethylthiocarbocyanine bromide (Thiazole Purple): 558, 526 in EtOH (346).
 $C_{19}H_{19}N_2S_2(I)$.—2, 2'-Diethylthiocyanine iodide: 423, 400 in EtOH (346); cf. (448).
 $C_{20}H_{16}N_2$.—*N*-Methylquinolylenequinaldine: base, 461 in EtOH (554).
 $C_{20}H_{18}N_3(I)$.—1, 1'-Dimethyl-2, 2'-azocyanine iodide: 424, 402, 285 in EtOH (205); 421, 396 in H_2O ; 375, 358 in concd. H_2SO_4 (472).
 $C_{20}H_{19}N_2S(I)$.—2-Methyl-1'-ethylthiopseudocyanine iodide: 485, (460) (207).
 1'-Methyl-2-ethylthiopseudocyanine iodide: 485, (460) (207).

$C_{20}H_{21}N_2(ClO_4)$.—*o*-Dimethylaminobenzylidenequinaldine methyl perchlorate: 455, 350 in EtOH (353 with HCl) (348).
p-Dimethylaminobenzylidenequinaldine methyl perchlorate: 515, 338 in EtOH (350 with HCl) (348).
p-Dimethylaminobenzylidenelepidine methyl perchlorate: 526, 293 in EtOH (348).
 $C_{20}H_{21}N_2S_2(I)$.—5 (or 5')-Methyl-2, 2'-diethylthiocyanine iodide: 427, 400 in EtOH (448).
 $C_{20}H_{22}N_3(I)$.—*p*-Dimethylaminoanil of quinaldine aldehyde ethiodide: 568 (205).
 $C_{21}H_{19}N_2(I)$.—1, 1'-Dimethylpseudocyanine iodide: 523, 488, 455 in EtOH; 317 with H_2SO_4 (340); cf. (150, 317).
 1, 1'-Dimethylisocyanine iodide: 558, 519 in EtOH (446); cf. (122, 202, 667); perchlorate, 545, 500, 286 in EtOH (317 with HCl) (348).
 $C_{21}H_{20}N_3(I)$.—5-Amino-1, 1'-dimethylisocyanine iodide: 555, 520 in EtOH (202).
 6-Amino-1, 1'-dimethylisocyanine iodide: 575, 535 in EtOH (202).
 7-Amino-1, 1'-dimethylisocyanine iodide: 570, 535 in EtOH (202).
 6'-Amino-1, 1'-dimethylisocyanine iodide: 570, 535 in EtOH (202).
 7'-Amino-1, 1'-dimethylisocyanine iodide: 545, 510 in EtOH (202).
 $C_{21}H_{21}N_2O_2(I)$.—2, 2'-Diethyloxacarbocyanine iodide: 485, 460 in EtOH (206).
 1', 6'-Dimethyl-2-ethylthioisocyanine iodide: 500, 487 in EtOH (56).
 2, 1'-Diethylthioisocyanine iodide: 503, 489 in EtOH (155).
 $C_{21}H_{21}N_2S(I)$.—2, 1'-Diethylthiopseudocyanine iodide: 493, 461 (449); 485, (460) (207).
 $C_{21}H_{21}N_2S_2(I)$.—2, 2'-Diethylcarbocyanine iodide: 559, 525 in EtOH (448).
 $C_{21}H_{23}N_2(I)$.—*p*-Dimethylaminobenzylidenequinaldine ethiodide: 532 (205).
 $C_{22}H_{21}N_2(I)$.—1-Methyl-1'-ethylisocyanine iodide: 558, 519 in EtOH (446).
 1, 6, 1'-Trimethylisocyanine iodide (Pinaverdol, C. I. 807): 558 in EtOH (667); cf. (361q, 668q).
 1, 1', 6'-Trimethylisocyanine iodide: 558 in EtOH (667).
 $C_{22}H_{23}N_2(ClO_4)$.—*p*-Dimethylaminocinnamylidenequinaldine methyl perchlorate: 523, 341 in EtOH (405 with HCl) (348).
 $C_{22}H_{23}N_2(I)$.—1, 3, 3, 1'-Tetramethylindopseudocyanine iodide: 470 in EtOH (207).
 $C_{22}H_{23}N_2S(I)$.—5, 1', 6'-Trimethyl-2-ethylthioisocyanine iodide: 507, 495 in EtOH (56).
 5-Methyl-2, 1'-diethylthioisocyanine iodide: 508, 492 in EtOH (56).
 $C_{23}H_{13}NO_5$.—Resorcinolquinolineine: 490 in alk. H_2O (467).
 $C_{23}H_{15}NO_4$.—Phenolquinolineine: 533 in alk. H_2O (467).
 $C_{23}H_{21}N_2(I)$.—1, 1'-Dimethyl-2, 2'-carbocyanine iodide: 607, 561, 521 in EtOH (331 with H_2SO_4) (340); cf. (203, 346, 667).
 1, 1'-Dimethyl-4, 4'-carbocyanine iodide: 715 in EtOH (206).
 $C_{23}H_{21}N_2S_2(Br)$.—2, 2'-Diallylcarbocyanine bromide: 560, 522 in EtOH (206).
 $C_{23}H_{22}N_3O(I)$.—5-Acetylamino-1, 1'-dimethylisocyanine iodide: 560, 525 in EtOH (202).
 6-Acetylamino-1, 1'-dimethylisocyanine iodide: 570, 530 in EtOH (202).
 7-Acetylamino-1, 1'-dimethylisocyanine iodide: 565, 530 in EtOH (202).
 6'-Acetylamino-1, 1'-dimethylisocyanine iodide: 565, 530 in EtOH (202).
 7'-Acetylamino-1, 1'-dimethylisocyanine iodide: 555, 525 in EtOH (202).

- $C_{23}H_{23}N_2(I)$.—1, 6, 1', 6'-Tetramethylisocyanine iodide: 562 in EtOH (667).
- 1, 6-Dimethyl-1'-ethylisocyanine iodide: 560 in EtOH (667).
- 1, 1'-Diethylisocyanine iodide (Ethyl Red, C. I. 807): 558, 517 in EtOH (446); *cf.* (301).
- 1, 6, 1', 6'-Tetramethylpseudocyanine iodide: 522, 490 in EtOH (207).
- 1, 1'-Diethylpseudocyanine iodide: 525, 490 in EtOH (207); *cf.* (555).
- $C_{23}H_{25}N_2(Br)$.—"Rosol red bromide": 526, 492, 276 in MeOH (342).
- $C_{23}H_{25}N_2OS(I)$.—6'-Ethoxy-2, 1'-diethylthioisocyanine iodide: 506, 493 in EtOH (56).
- $C_{24}H_{24}ClN_2(I)$.—6-Methyl-6'-chloro-1, 1'-diethylisocyanine iodide: 575, 540 in EtOH (587).
- 6-Chloro-6'-methyl-1, 1'-diethylisocyanine iodide: 575, 547 in EtOH (587).
- $C_{24}H_{24}N_2(I)$.—*p*-Dimethylaminoanil of β -naphthoquinaldine aldehyde ethiodide: 560 in EtOH (205).
- $C_{24}H_{25}N_2(I)$.—2'-Methyl-1, 1'-diethylisocyanine iodide: 559, 518 (301).
- 7-Methyl-1, 1'-diethylisocyanine iodide: 570, 535 in EtOH (587).
- 6 (or 6')-Methyl-1, 1'-diethylpseudocyanine iodide: 530, 495 in EtOH (207).
- $C_{23}H_{25}N_2S_2(I)$.—5, 5'-Dimethyl-2, 2'-diethylthiocarbocyanine iodide: 563, 529 in EtOH (448).
- $C_{24}H_{27}N_2(I)$.—3, 3-Dimethyl-1, 1'-diethylindopseudocyanine iodide: 480 in EtOH (207).
- $C_{24}H_{27}N_2OS(I)$.—6'-Ethoxy-5-methyl-2, 1'-diethylthioisocyanine iodide: 511, 499 in EtOH (56).
- $C_{25}H_{17}NO_5$.—Orcinolquinoline: 496 in alk. H_2O (467).
- $C_{25}H_{19}NO_5$.—*o*-Cresolquinoline: 544 in alk. H_2O (467).
- $C_{25}H_{21}N_2(I)$.—1, 1'-Dimethyl-5, 6 (or 5', 6')-benzopseudocyanine iodide: 538, 500 in EtOH (207).
- $C_{25}H_{25}N_2(I)$.—*p*-Dimethylaminobenzylidene- β -naphthoquinaldine ethiodide: 525 in EtOH (205).
- 1, 6, 1', 6'-Tetramethyl-2, 2'-carbocyanine iodide: 570, 530 in EtOH (202).
- 1, 1'-Diethylcarbocyanine iodide (Pinacyanol, C. I. 808): infra-red abs. (387); 607, 562.5, 519.2 in EtOH (451); *cf.* (149, 203, 340, 362q, 363q, 450q, 668q).
- 1, 4, 1', 2'-Tetramethyl-2, 4'-carbocyanine iodide: 653, 606 (667).
- 1, 1'-Diethyl-2, 4'-carbocyanine iodide: 657, 606.5 in EtOH (450q).
- 1, 1'-Diethyl-4, 4'-carbocyanine iodide (Kryptocyanine, C. I. 810): 711.5, 655 in EtOH (450q); *cf.* (449).
- $C_{26}H_{27}Cl_2N_2(I)$.—5, 5'-Dichloro-1, 3, 3, 1', 3', 3'-hexamethylindocarbocyanine iodide: 551, 517, (489) in MeOH (342).
- $C_{26}H_{27}N_2(I)$.—1, 1'-Diethyl-6, 6'-dimethylisocyanine iodide (Orthochrome T, C. I. 807): 520 in alk. H_2O (concd.); 570 (dil.) (269); *cf.* (362).
- Propylisocyanine: 563, 522 in EtOH (446).
- $C_{25}H_{27}N_2O(I)$.—1, 1'-Diethyl-6-methoxy-6'-methylisocyanine iodide: 580, 540 in EtOH (587).
- 1, 1'-Diethyl-6-methyl-6'-methoxyisocyanine iodide: 575, 540 in EtOH (587).
- 1, 1'-Diethyl-6'-ethoxyisocyanine iodide: 575, 540 in EtOH (587).
- $C_{26}H_{27}N_2O_2(I)$.—1, 1'-Diethyl-6, 6'-dimethoxyisocyanine iodide: 585, 560 in EtOH (587).
- $C_{26}H_{27}N_4(I)$.—1, 1'-Diethyl-6, 6'-diaminocarbocyanine iodide: 640, 595 in EtOH (204).
- $C_{26}H_{29}N_2(I)$.—1, 3, 3, 1', 3', 3'-Hexamethylindocarbocyanine iodide (Indolenine Red): 548, 512 in EtOH (206); *cf.* (346); 546, 512, (483), 281 in MeOH (342).
- $C_{26}H_{19}N_2(Cl)$.—1, 1'-Benzylidene-2, 2'-quinocyanine chloride (Quinoline Red, C. I. 805): 536, 499 (78).
- $C_{26}H_{29}N_2(I)$.—Methylhexylisocyanine iodide: 560, 519 in EtOH (446).
- $C_{26}H_{29}N_2O(I)$.—1, 1'-Diethyl-6-methyl-6'-ethoxyisocyanine iodide: 575, 545 in EtOH; 580 in $CHCl_3$ or C_7H_8 ; 590 in C_6H_7N (587); bromide, 575, 535 in H_2O ; 577, 535 in EtOH; 583, 540 in $CHCl_3$ (influence of temp. given) (588).
- 1, 1'-Diethyl-6-ethoxy-6'-methylisocyanine iodide: 580, 545 in EtOH (587).
- $C_{26}H_{29}N_2O_2(I)$.—1, 1'-Diethyl-6-ethoxy-6'-methoxyisocyanine iodide (Pinachrome, C. I. 807): 530 in alk. H_2O (concd.); 575 (dil.); 580 in EtOH (95%) (269); 535 in H_2O ; 650, 595 in EtOH (588); *cf.* (361q).
- $C_{27}H_{25}N_2(I)$.—1, 1'-Diallyl-4, 4'-carbocyanine iodide: 715 in EtOH (206).
- 1, 1'-Diethyl-5, 6 (or 5', 6')-benzopseudocyanine iodide: 538, 500 in EtOH (207).
- Diethylbenzocyanine iodide (?): 580, 548 in EtOH (341).
- $C_{27}H_{29}N_2(Br)$.—1, 1'-Diethyl-4, 4'-dimethyl-2, 2'-carbocyanine bromide (Fischer's α -Pseudodicyanine): 606, 559 in EtOH (316).
- $C_{27}H_{29}N_2(Cl)$.—1, 1'-Diethyl-6, 6'-dimethyl-2, 2'-carbocyanine chloride: 613, 566 in EtOH (316).
- $C_{27}H_{29}N_2(I)$.—1, 1'-Diethyl-2', 4-dimethyl-2, 4'-carbocyanine iodide (Fischer's α -Dicyanine): 655.5, 603.5 in EtOH (450q); *cf.* (149, 667).
- $C_{27}H_{33}N_2(I)$.—3, 3, 3', 3'-Tetramethyl-1, 1'-diethylindocarbocyanine iodide: 548, 512 in EtOH (206).
- $C_{28}H_{19}N_3$.—*sym.*-Triquinolyl-2-methane: 523, 487 in EtOH (556).
- $C_{28}H_{25}N_2(I)$.—1-Ethyl-1'-methyl-2'-phenylisocyanine iodide: 565, 525 in H_2O or EtOH (301).
- $C_{28}H_{27}N_2(I)$.—1, 1'-Diethyl-6'-methyl-5, 6-benzocyanine iodide (?): 585, 550 in EtOH (341).
- $C_{29}H_{27}N_2(Br)$.—1, 1'-Diethyl-5, 6-benzocarbocyanine bromide: 625, 575, 535 in EtOH (451).
- $C_{29}H_{29}N_2(I)$.—6, 6'-Dimethyl-1, 1'-diallyl-2, 2'-carbocyanine iodide: 620, 570 in EtOH (206).
- $C_{29}H_{31}N_4O_2(I)$.—1, 1'-Diethyl-6, 6'-diacetylaminocarbocyanine iodide: 625, 575 in EtOH (204).
- $C_{29}H_{33}N_2(I)$.—1, 1'-Diethyl-4, 6, 4', 6'-tetramethyl-2, 2'-carbocyanine iodide (Fischer's "Pseudodicyanine Iodide"): 611, 565 in EtOH (316).
- $C_{29}H_{33}N_2(Br)$.—1, 1'-Diethyl-4, 6, 2', 6'-tetramethyl-2, 4'-carbocyanine bromide (Fischer's "Dicyanine Bromide"): 662, 610 in EtOH (317).
- $C_{29}H_{33}N_2O_2(I)$.—1, 1'-Diethyl-5, 5'-diethoxycarbocyanine iodide: 603, 559 in EtOH (55).
- 1, 1'-Diethyl-6, 6'-diethoxycarbocyanine iodide: 622, 576 in EtOH (55).
- 1, 1'-Diethyl-7, 7'-diethoxycarbocyanine iodide: 617, 571 in EtOH (55).
- $C_{29}H_{35}N_2(I)$.—1, 1'-Diisomylecyanine iodide (Cyanine, C. I. 806): infra-red abs., 0.7, 3.3, (5.1), 6.6, 7.5, 8.5, 9.5, 10.4 μ (296); *cf.* (80, 510, 511); 586, 550 in H_2O ; 595, 552 in EtOH (3); *cf.* (114q, 361q, 362q, 528q); influence of temp. (334, 363q).
- $C_{29}H_{35}N_2O_2(I)$.—1, 1'-Diethyl-2, 2'-dimethyl-6, 6'-diethoxycyanine iodide: 620 in EtOH (500).
- $C_{30}H_{26}N_3O(I)$.—5-Cinnamoylamino-1, 1'-dimethylisocyanine iodide: 560, 525 in EtOH (202).
- 6-Cinnamoylamino-1, 1'-dimethylisocyanine iodide: 575, 535 in EtOH (202).
- 6'-Cinnamoylamino-1, 1'-dimethylisocyanine iodide: 570, 530 in EtOH (202).
- 7'-Cinnamoylamino-1, 1'-dimethylisocyanine iodide: 560, 520 in EtOH (202).

$C_{21}H_{31}NO_4$.—Thymolquinolineine: 593 in alk. soln. (467).

$C_{31}H_{37}N_2O_2(I)$.—1, 1'-Diethyl-4, 2'-dimethyl-6, 6'-diethoxy-2, 4'-carbocyanine iodide (Dicyanine A, C. I. 811): 672 in EtOH (500); band at 1.4μ (387).

$C_{33}H_{27}N_2(I)$.—4, 4'-Diphenyl-1, 1'-dimethylpseudocyanine iodide: 541, 501 (150).

$C_{33}H_{27}N_2(Br)$.—5, 6, 5', 6'-Dibenzo-1, 1'-diethylcarbocyanine bromide: 638, 588, 550 in EtOH (451).

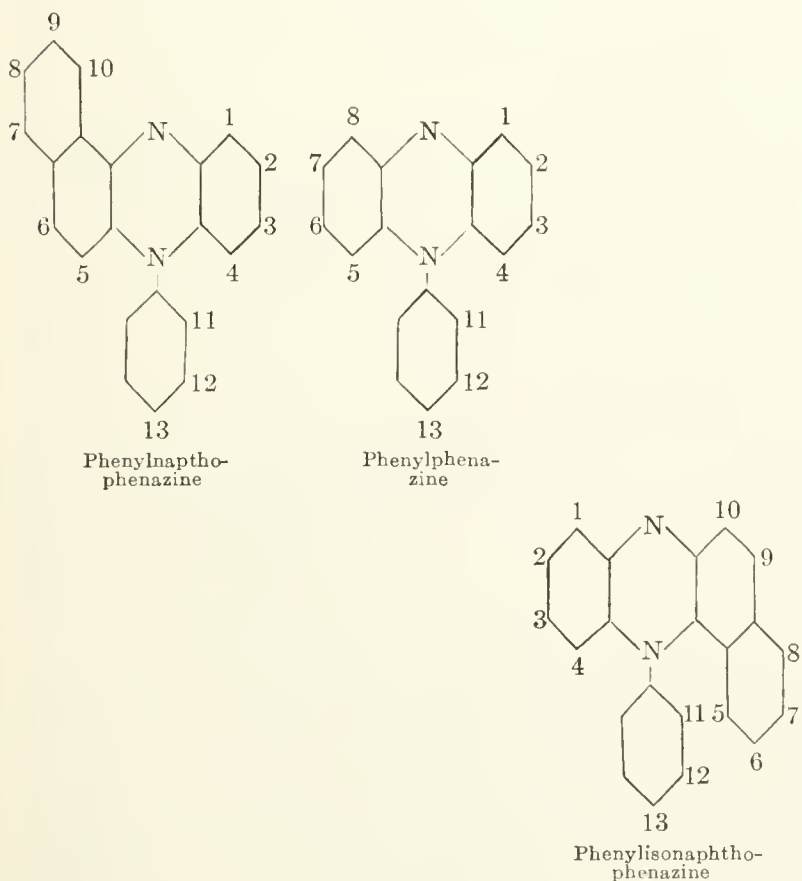
$C_{35}H_{29}N_2(I)$.—4, 4'-Diphenyl-1, 1'-diethylcarbocyanine iodide: 624, 576 in EtOH (149).

$C_{35}H_{33}N_2(I)$.—4, 4'-Diphenyl-1, 6, 1', 6'-tetramethylpseudocyanine iodide: 547, 507 in EtOH (150).

$C_{37}H_{33}N_2(I)$.—4, 4'-Diphenyl-1, 6, 1', 6'-tetramethylcarbocyanine iodide: 631, 581 in EtOH (149).

$C_{44}H_{44}ClN_4O_6(I)$.—4'-Chloro-3, 3'-di-(*o*-carbethoxyphenylmethylcarbonyl)-1, 2, 1'-trimethylisocyanine iodide: 574, 325 (250).

TABLE 7.—AZINE DERIVATIVES



$C_{12}H_8N_2$.—Phenazine: 355 in EtOH (217); cf. (111, 317); 360, (240) in Et₂O (309); monacid salt, 450, 385, 255 (309); cf. (317); diacid salt, 552, 506, 395, 265 (317); cf. (309, 316).

$C_{12}H_8N_2O_2$.—3, 6-Dihydroxyphenazine: 510 (465).

$C_{12}H_9N_3$.—3-Aminophenazine: 472, 265 in EtOH (317); 468, 365, 265 in Et₂O (309); monacid salt, 557, 516, 385, 285, 255 in H₂O (309); cf. (155); 557, 516.8, 483 in EtOH (155); 385, 280 (317); diacid salt, 750 in HCl; triacid salt, 541, 506 in H₂SO₄ (317); cf. (309).

$C_{12}H_{10}N_4$.—2, 3-Diaminophenazine: 454, 285, 265 in EtOH (317); chloride, 483.7, 455.5, 433.8 in EtOH (155); 285 (317); diacid salt, 505, 463 in EtOH; triacid salt, 505 in H₂SO₄; tetraacid salt (598), (489) in fuming H₂SO₄ (317).

$C_{12}H_{10}N_4$.—3, 6-Diaminophenazine: 447, 265 in EtOH (317); chloride, 513, 491.5 in H₂O (155); 521.7, 490 in EtOH (155); 280 (317); diacid salt, 580 in EtOH; polyacidic salts (317).

$C_{12}H_{10}N_4$.—Aminophenylphenazine: 310 in EtOH + HCl (377).

$C_{13}H_{10}N_4O_4$.—1, 3-Dinitromethyldihydrophenazine: 581, 538 (304).

$C_{13}H_{11}N_2$.—*N*-Methylphenazine: monacid salt, 390, 260 in acid EtOH; diacid salts, 560, 510, 400, 265 in H₂SO₄ (316); cf. (309); holo- and merquinoid salts (217).

$C_{13}H_{11}N_3$.—3-Aminomethylphenazine: 530, 505, 490 in Et₂O; monacid salt, 562, 525, (494), 385, 285 in EtOH; diacid salt, 674.5, 610, 459 in H₂SO₄; triacid salt, 520, 490 in fuming H₂SO₄ (319); cf. (308, 309).

$C_{13}H_{13}N_4(ClO_4)$.—3, 6-Diaminomethylphenazine perchlorate: 530, 483 in EtOH (320); cf. (318).

$C_{15}H_{13}N_4(Cl)$.—Cyantrypaflavine: 538, 501, 275 in EtOH (221).

$C_{16}H_{19}N_4(Cl)$.—3, 5-Tetramethyldiaminophenazonium chloride: 510 in H₂O (465).

$C_{17}H_{21}N_4(Cl)$.—3, 5-Tetramethyldiaminomethylphenazonium chloride: 567, 280, 265 in EtOH (182).

$C_{18}H_{10}N_4$.—Phenazineazine: 431 (111).

$C_{18}H_{12}Cl_2N_2(Cl)$.—3, 6-Dichlorophenylphenazonium chloride: 411, 269 in EtOH (23).

$C_{18}H_{12}N_2O_2$.—Hydroxyaposafranine: 488, 268 in dil. NaOH soln.; 479, 270 in dil. HCl (23).

$C_{18}H_{13}N_2$.—Phenylphenazine: monacid salt, 395, 265 in EtOH; diacid salt, 570, 525, 416, 270 in H₂SO₄ (316); cf. (309).

$C_{18}H_{13}N_3$.—1-Aminophenylphenazine: monacid salt, 487, 390, 310, 240 (nitrate in EtOH) (319); cf. (245); diacid salt, 390, 263 in H₂SO₄; triacid salt, 603, 485 in 100% H₂SO₄ (319); cf. (309).

2-Aminophenylphenazine: monacid salt, 582 in EtOH; diacid salt, 400, 288 in EtOH + H₂SO₄; triacid salt, 575, 470 in H₂SO₄ (319).

3-Aminophenylphenazine (Aposafarine): 555, 512, 483 in EtOH (319); 290 (309); monacid salt, 563, 519, 483, 390, 285 in EtOH; diacid salt, 694, 625, 570, (465), 420, 285 in 60% H₂SO₄; triacid salt, 580, 520, 490, 420, 270 in H₂SO₄ (319); cf. (155, 309, 324).

$C_{18}H_{15}N_3$.—Dimethylnaptheurhodine: 482 in EtOH (or CHCl₃) (377).

$C_{18}H_{15}N_4(ClO_4)$.—1, 3-Diaminophenylphenazine perchlorate: 585, 463, 431, 295 in EtOH; diacid salt, 564, 530, 490, 395, 285 in EtOH + H₂SO₄; triacid salt, 483 in H₂SO₄; tetraacid salt, 530 in fuming H₂SO₄ (320); cf. (308, 309).

2, 6-Diaminophenylphenazine perchlorate: 640, 605, 330, 295 in EtOH; diacid salt, 565, 528, 483, 390, 285 in EtOH + H₂SO₄; triacid salt, 610, (583), 410, 295 in H₂SO₄ (320); cf. (309).

$C_{18}H_{15}N_4(Cl)$.—2, 13-Diaminophenylphenazine chloride: monacid salt (460), 400, 297, 265 in acid EtOH; abs. of diacid salt indefinite; triacid salt, 563, 518, 410, 275 in concd. H₂SO₄ (309).

3, 6-Diaminophenylphenazine chloride (Phenosafarine, C. I. 840): 525, 494 in H₂O (155); 534, 501, 270 in EtOH; diacid salt (645), 586, 400, 290 in acid EtOH; triacid salt, (583) in H₂SO₄; tetraacid salt, 570 in fuming H₂SO₄ (320); influence of concn. (269); cf. (23, 359, 221, 308, 309, 467). Phenosafranineazodimethylaniline, 579; phenosafranine-disazo-*bis*-dimethylaniline: 513 (111).

3, 7-Diaminophenylphenazine chloride: diacid salt, 567, 530 in acid EtOH (308).

3, 11-Diaminophenylphenazine chloride: 572, 535, 490 in EtOH; diacid salt, 565, 525 in acid EtOH (308); cf. (246).

3, 13-Diaminophenylphenazine chloride: 572, 535, 490, 395, 285 in H₂O; diacid salt, 565, 525, 490, 400, 286 in dil. H₂SO₄ (309); cf. (35).

$C_{19}H_{15}N_3$.—3-Phenylaminomethylphenazine: 525 in Et₂O; monacid salt, 565, 410, 285 in EtOH; diacid salt, 478 in H₂SO₄ (319).

$C_{20}H_{15}N_3O$.—2-Acetylaminophenylphenazine: monacid salt, 500, 400, 285 in EtOH; diacid salt, 570, 515, (470) in H₂SO₄ (319).

$C_{20}H_{16}N_3O$.—3-Acetylaminophenylphenazine: 564, 530, 499 in EtOH; monacid salt, 508, (489), (472), 410, 285 in EtOH; diacid salt, 579, 520, 441, 415 in H_2SO_4 (319); cf. (309).

$C_{20}H_{17}N_4O(Cl)$.—1-Acetyl-amino-3-aminophenylphenazine chloride: 590, 548 in EtOH (320).

2-Acetylaminophenylphenazine chloride: 582, 543 in EtOH (320).

$C_{20}H_{19}N_4(Cl)$.—*asym.*-Dimethylphenosafranine chloride (C. I. 842): 550, 526.5 in H_2O ; 551.9, 511.5 in EtOH; 555, 514.4 in AmOH (155).

Ethylphenosafranine chloride: 537.5, 502.4 in H_2O ; 539.3, 500 in EtOH; 543, 503 in AmOH (155).

$C_{21}H_{21}N_4(Cl)$.—Diamino-*o*-tolyliditolazine chloride (with phenyl isomer, commercial Safranine, C. I. 841): 495 in H_2O (concd.); 515 (dil.) (269); ultra-violet abs. and influence of acidity (388); on silk (10, 627); 535, 515 on wool (522); cf. (1629, 391). Safranine-azodimethylaniline (C. I. 133): infra-red abs. (511). Safranine-azo- β -naphthol (C. I. 135): 600 on cotton, 608.5 with tannin mordant (627).

$C_{22}H_{15}N_2$.—Phenyl-naphthophenazine: monacid salt, 480, 290; diacid salt, 524, 513, 484, 303 (321); cf. (324).

Phenylisonaphthophenazine: monacid salt (475), 415, 292 in H_2O (325); 496 in EtOH (322); diacid salt, 632, 598, 503, 310 in H_2SO_4 (325); cf. (322).

$C_{22}H_{15}N_3$.—2-Aminophenyl-naphthophenazine: monacid salt, 545, (490), 440, 312, 290; diacid salt, 290; triacid salt, 510, 485, 305 (321); cf. (324).

2-Aminophenylisonaphthophenazine: 580, 560, 465, perchlorate in EtOH; diacid salt, 490 in 50% H_2SO_4 ; triacid salt, 590, 506, 450 in fuming H_2SO_4 (322); cf. (325).

3-Aminophenyl-naphthophenazine (Isorosinduline): 575, 531, 493 in Et₂O; monacid salt, 565, 533, 425, 310, 282, 265; diacid salt, 690, 481, 285; triacid salt, 529, 517, 485, 302 (321); cf. (324).

3-Aminophenylisonaphthophenazine: monacid salt, 581, 540, 499; diacid salt, 430 in 50% H_2SO_4 ; triacid salt, 590, 505, 450 in fuming H_2SO_4 (322); cf. (325).

6-Aminophenyl-naphthophenazine (Rosinduline): 599, 556, 516, 483 in Et₂O; monacid salt, 533, 501, 472, 313; diacid salt, 668, 605, 555, (453), 335; triacid salt, 530, 512, 490 (321); cf. (324).

6-Aminophenylisonaphthophenazine: monacid salt, 581, 545, (425), 335, 270 in H_2O ; diacid salt, 395, 293 in 30% H_2SO_4 ; triacid salt, 586, 539, 482, 303 in concd. H_2SO_4 (325); cf. (322).

7-Aminophenyl-naphthophenazine: monacid salt (577), 350, 277; diacid salt, 288; triacid salt, 583, 500, 302 (321); cf. (324).

7-Aminophenylisonaphthophenazine: monacid salt, 580, 544, 335, 285 in H_2O ; diacid salt, 462, 296 in 35% H_2SO_4 ; triacid salt, 583, 535, 485, 305 in concd. H_2SO_4 (325); cf. (322).

8-Aminophenyl-naphthophenazine: monacid salt, (486), 456, 333, 285; diacid salt 290; triacid salt, 577, 496, 460, 304 (321); cf. (324).

8-Aminophenylisonaphthophenazine: monacid salt, 586, 547, 457, (362), 332, 272 in H_2O ; diacid salt (475), 400, 290 in 30% H_2SO_4 ; triacid salt, 584, 536, 482, 303 in concd. H_2SO_4 (325); cf. (322).

9-Aminophenyl-naphthophenazine: monacid salt, 585, 480, 442, 335; diacid salt, 287; triacid salt, 579, 495, 460, 288 (321); cf. (324).

9-Aminophenylisonaphthophenazine: monacid salt, 585, 553, 408, 325 in H_2O ; diacid salt, 580, 458, 333, in 50% H_2SO_4 ; triacid salt, 583, 532, 508, 450, 310 in H_2SO_4 (325); cf. (322).

10-Aminophenyl-naphthophenazine: monacid salt, (465), 290; diacid salt, 290 (321); cf. (324).

10-Aminophenylisonaphthophenazine: chloride in H_2O , 420, 335, 260 (245); diacid salt, 489, (450) in dil. H_2SO_4 ; triacid salt, 585, 535, 490 (322).

12-Aminophenyl-naphthophenazine: monacid salt, 287; diacid salt, 290; triacid salt, (645, 593), (520, 488, 452), 310 (321); cf. (324).

13-Aminophenyl-naphthophenazine: monacid salt, 287; diacid salt, 290; triacid salt, (590), (528, 492), (540), (310) (321); cf. (324).

13-Aminophenylisonaphthophenazine: perchlorate in EtOH, 475; diacid salt, 488 in 10% H_2SO_4 ; triacid salt, 590, 500, (470?), 450 in concd. H_2SO_4 (322).

$C_{22}H_{19}N_4O_2(Cl)$.—1, 3-Di-(acetyl-amino)-phenylphenazine chloride: 580, 505 in EtOH (320).

2, 6-Di-(acetyl-amino)-phenylphenazine chloride: 545, 504 in EtOH (320).

$C_{22}H_{23}N_4(Cl)$.—*asym.*-Diethylphenosafranine chloride: 561.8, 531.2 in H_2O ; 556.1, 569.3 in EtOH; 558.5, 517.5 in AmOH (155).

$C_{24}H_{12}N_6$.—Phenazineazineazine: 432 (111).

$C_{24}H_{17}ClN_3(Cl)$.—3-Chloro-6-phenylaminophenylphenazine: 545, 405, 316 (23).

$C_{24}H_{18}N_3$.—3-Phenylaminophenylphenazine: 516 in Et₂O; monacid salt, 569.3, 400, 285 in EtOH; diacid salt, 490 in H_2SO_4 (319).

$C_{24}H_{18}N_4$.—2, 3-Di-(phenylamino)-phenazine: 480, 285 in EtOH; monacid salt, 508, 285 in EtOH; diacid salt, 542 (317).

$C_{24}H_{19}N_4(Cl)$.—Phenylphenosafranine chloride: 547 in H_2O ; 556 in EtOH; 561 in AmOH (155).

$C_{24}H_{30}N_3(Cl)$.—Dimethylisorosinduline chloride (Neutral Blue, C. I. 832): infra-red abs. (296).

$C_{26}H_{21}N_4(ClO_4)$.—3, 6-Di-(phenylamino)-methylphenazine perchlorate: 572 in EtOH (320).

$C_{26}H_{22}N_4$.—3, 6-Di-(tolylamino)-phenazine: 494, 285 in EtOH; monacid salt, 572, 285 in EtOH; polyacidic salts (317). Indazine M: 598.5 on cotton; 610 with tannin mordant (627).

$C_{26}H_{31}N_4(Cl)$.—Tetraethylphenosafranine chloride (C. I. 847): 589, 548.9 in H_2O ; 578.7, 534.8 in EtOH; 580.2, 535.7 in AmOH (155); 579, 535, 285 in EtOH (221); perchlorate in EtOH, 595, 545 (320).

$C_{27}H_{26}N_4(ClO_4)$.—3, 6-Di-(*p*-tolylamino)-methylphenazine perchlorate: 580 in EtOH (320).

Aminophenylamino-*p*-tolyliditolazonium salts (and homologs) C. I. 846: Aniline violet, various salts (497).

$C_{28}H_{19}ClN_3(NO_3)$.—3-Chloro-6- α -naphthylaminophenylphenazine nitrate: 549, 390, 303 (23).

$C_{30}H_{20}N_3Cl$.—Aminonaphthylidinaphthazine and diamino isomer (Magdala Red, C. I. 857): 570 in EtOH; 575 in $C_6H_5NH_2$ (2999).

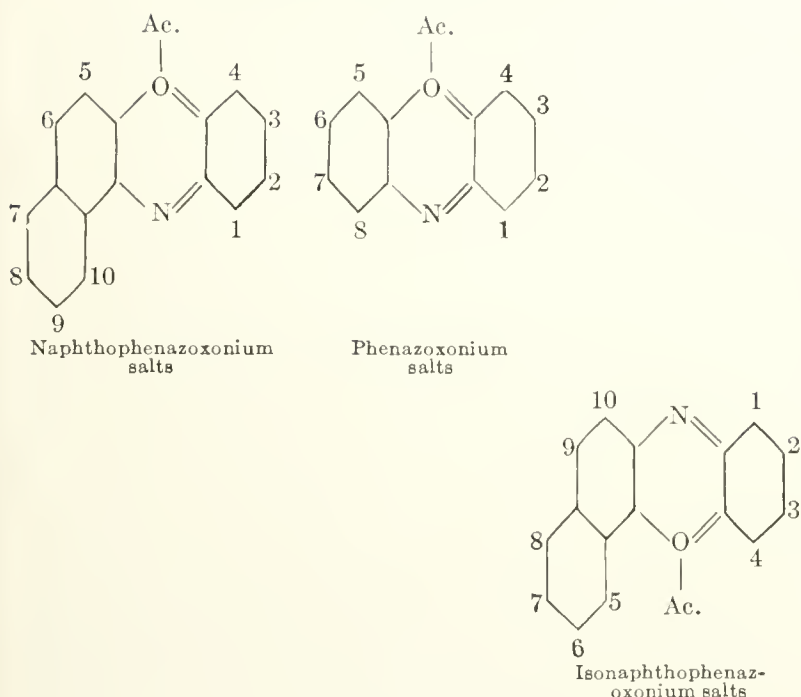
$C_{30}H_{23}N_4(Cl)$.—*sym.*-Diphenylphenosafranine chloride: 570.7 in H_2O ; 580.7 in EtOH; 585.7 in AmOH (155).

$C_{34}H_{24}ClN_4(NO_3)$.—3-Chloro-7-phenylamino-6-naphthylaminophenylphenazine nitrate: 561, 303 (23).

$C_{34}H_{26}N_4(NO_3)$.—3-Phenylamino-6- α -naphthylaminophenylphenazine nitrate: 561, 302 (23).

Fast Blue: influence of concn. (299). Induline dyes: (65). Nigrosine SS: infra-red abs. (387). Rhoduline Blue R: 550 in H_2O (concd.), 565 (dil.) (269). Rhoduline Red B (C. I. 844): 510 in H_2O (concd.), 533 (dil.) (269). Azine and eurhodol dyes obtained from the reduction products of azo dyes (123).

TABLE 8.—OXAZINE DERIVATIVES



$C_{12}H_2Br_4NO_3(NH_4)$.—Tetrabromoresorufin, NH_4 salt (C. I. 908): (481).

$C_{12}H_5N_5O_9$.—1, 3, 5, 7-Tetranitrophenazoxine: (304).

1, 3, 6, 7-Tetranitrophenazoxine: 642 in alk. EtOH (304).

1, 3, 6, 8-Tetranitrophenazoxine: 632 in alk. EtOH (304).

$C_{12}H_6N_4O_7$.—1, 3, 6-Trinitrophenazoxine: 639 in alk. EtOH (304).

1, 3, 7-Trinitrophenazoxine: 505 in alk. EtOH (304).

$C_{12}H_7N_2O_3$.—Resorufin: 568, 422 in EtOH (648); K salt, 573.6, 554.8, 530.8 in H_2O ; 588.5, 578.8, 559.4, 540.1 in EtOH; 592.4, 580.5, 561.2, 543.5 in AmOH (155); cf. (465, 497).

$C_{12}H_7NO_4$.—Resazurin: Na salt, 601, 555.9 in H_2O ; 610.2, 587.5 in EtOH; 629.8, 612, 592.5, 574, 559.6 in AmOH (155); cf. (497).

$C_{12}H_7N_3O_5$.—1, 3-Dinitrophenazoxine: 534, 502 in EtOH (304).

3, 6-Dinitrophenazoxine: 704 in alk. EtOH (304).

$C_{12}H_8NO$.—Phenazoxonium salts: monoacid, 505 (312); 410, 313 (309); diacid, 460 (in $H_2SO_4 + H_2O_2$) (312).

$C_{12}H_8N_2O_3$.—3-Nitrophenazoxine: 678, 618, 572 in alk. EtOH (304).

$C_{12}H_8N_2O_2$.—Resorufamine: 577.7, 533.9 in H_2O ; 578.7, 535.7 in EtOH; 580.2, 536.6 in AmOH (155).

$C_{12}H_9N_2O$.—1-Aminophenazoxonium salts: monoacid, 400, 285, 265; diacid, 535, (480), 430, 265 (in H_2SO_4) (312); cf. (309).

3-Aminophenazoxonium salts: monoacid, 492, 285, 265; diacid, 640, 590, 285, 265 (312); cf. (309).

$C_{12}H_{10}N_3O$.—1, 3-Diaminophenazoxonium salts: monoacid, (440) in dil. H_2SO_4 ; diacid (568), 529, 265 in 50% H_2SO_4 (309).

3, 6-Diaminophenazoxonium salts: chloride, 586.8, 541.5 in H_2O ; 593, 574.5, 545.1 in EtOH; 598.3, 579.5, 549.5 in AmOH (155); bands at (410) in H_2O (309) and at 285, 265 in EtOH (313); triacid salt, 522 (with fuming H_2SO_4) (309).

$C_{14}H_{12}N_2O_2$.—Dimethylresorufamine: 591.7, 545.5 in H_2O ; 580, 538.5 in EtOH; 576.2, 535.7 in AmOH (155).

$C_{14}H_{12}NO$.—3, 6-Dimethylphenazoxonium salts: monoacid, 560, (460); diacid, 500 (in H_2SO_4) (312); cf. (309).

$C_{14}H_{14}N_3O(Cl)$.—*asym.*-3, 6-Dimethyldiaminophenazoxonium chloride: 619.5, 570 in H_2O ; 616, 597.1, 566.8 in EtOH; 618, 598.5, 568.2 in AmOH (155).

$C_{16}H_{12}N_2O_5$.—Dimethylaminohydroxycarboxydiphenoxazone (C. I. 883): Galloeyanine W, 520 in H_2O (concd.), 620 (dil.) (269).

$C_{16}H_{16}N_3O(Cl)$.—3, 5-Trimethyldiaminophenazoxonium chlo-

ride: 633.1, 579 in H_2O ; 628.5, 609.9, 575.3, in EtOH; 630.6, 611.1, 577 in AmOH (155).

3-Aminopheno-6-dimethylamino-*o*-tolazoxonium chloride: 628.2, 578.5 in H_2O ; 625.7, 603.9, 576 in EtOH; 628.2, 606.7, 578.5 in AmOH (155); cf. (494). Brilliant Cresyl Blue, 575 in H_2O (concd.), 625 (dil.); base, 485 in $CHCl_3$ (677).

$C_{16}H_{11}N_2O$.—3-Aminonaphthophenazoxonium salts: chloride, 581.7, 538.5, 500.2 in H_2O (155); 586, 540, 499, 275, 315 in EtOH; triacid salt, 580 in 25% oleum; base, 519 in Et₂O (315).

6-Aminonaphthophenazoxonium salts: chloride, 464, 335, 285, 265 in EtOH (315); diacid salt, 575 in concd. H_2SO_4 (303); cf. (315).

$C_{16}H_{12}N_3O$.—3, 6-Diaminonaphthophenazoxonium salts: chloride, 590.4, 544.5 in H_2O ; 610.5, 593, 545.5 in EtOH; 615.9, 595.6, 570.7 in AmOH (155); monoacid salt, ultra-violet bands at 320, 266 in EtOH; diacid salt, 460 in H_2SO_4 ; triacid salt, 585 in oleum (315).

3, 6-Tetramethyldiaminophenazoxonium salts: chloride, 648.9, 591.4 in H_2O ; 643.3, 620.7, 588.6 in EtOH; 644.6, 622.3, 589.8 in AmOH (155); nitrate, 645, 588, 285, 260 in EtOH (313); cf. (221); triacid salt, 557, 518 (oleum) (309).

asym.-3, 6-Diethyldiaminophenazoxonium chloride: 622.5, 573.2 in H_2O ; 619.2, 598.5, 569.3 in EtOH; 621.3, 599.9, 571 in AmOH (155).

asym.-3, 6-Dimethyldiamino-2,7-di-*o*-tolazoxonium chloride: 631.4, 581 in H_2O ; 628.5, 606.9, 578.5 in EtOH; 629.8, 608.4, 580 in AmOH (155).

$C_{17}H_{20}N_3O(Cl)$.—3, 6-Tetramethyldiaminopheno-*o*-tolazoxonium chloride: 660, 602.2 in H_2O ; 653.7, 597 in EtOH; 655.2, 633.7, 597.9 in AmOH (155).

$C_{18}H_{14}N_3O(Cl)$.—3, 6-Phenyldiaminophenazoxonium chloride: 605, 285, 265 in EtOH (312).

$C_{18}H_{15}N_2O$.—3-Dimethylaminonaphthophenazoxonium salts: chloride, 620.1, 572, 531.2 in H_2O ; 623, 574.5, 533 in EtOH; 628.8, 578.2, 536.1 in AmOH (155); cf. (249, 303, 315); diacid salt, 520 (H_2SO_4) (315); influence of concn. (269). (Meldola's Blue, C. I. 909.)

3-Dimethylaminoisonaphthophenazoxonium salts: nitrate in EtOH with trace of HCl, 620, 582 (303).

$C_{18}H_{15}N_2O_2(Cl)$.—3-Dimethylamino-9-hydroxynaphthophenazoxonium chloride (C. I. 915): 627.8, 575.7, 534.8 in H_2O ; 637.6, 584.5, 541.5 in EtOH; 647.2, 591.4, 547.5 in AmOH (155).

$C_{18}H_{16}N_3O(Cl)$.—3-Dimethylamino-6-aminonaphthophenazoxonium chloride: 636.4, 582.7 in H_2O ; 624.5 in EtOH; 623.6 in AmOH (155); cf. (183, 303).

$C_{18}H_{22}N_3O(Cl)$.—*asym.*-3, 6-Dimethyldiethyldiaminophenazoxonium chloride: 651.7, 594.5 in H_2O ; 645.1, 622, 590.9 in EtOH; 646.9, 623.9, 591.9 in AmOH (155).

3, 6-Triethyldiaminophenazoxonium chloride: 637.4, 584.5 in H_2O ; 632.4, (611.1), 579 in EtOH; 634.2, 612.3, 581 in AmOH (155).

$C_{19}H_{18}N_3O(Cl)$.—3-Dimethylamino-6-aminonaphtho-*o*-tolazoxonium chloride (Cresyl Violet): 585 in H_2O ; 603 in EtOH (6); cf. (1624).

$C_{19}H_{24}N_3O(Cl)$.—3-Dimethylaminopheno-6-diethylamino-*o*-tolazoxonium chloride (C. I. 876): 644.4, 606.4 in H_2O ; 656.7, 599.9 in EtOH; 658.1, 636, 601.3 in AmOH (155).

3-Diethylaminopheno-6-dimethylamino-*o*-tolazoxonium chloride: 653.7, 632.7, 597.1 in EtOH; 656.3, 634.7, 599.6 in AmOH; 603 in H_2O (155).

$C_{20}H_{18}N_3O(Cl)$.—3-Phenylamino-6-dimethylaminophenazoxonium chloride: 651, 265 in EtOH (313).

9-Acetylaminopheno-3-dimethylaminoisonaphthophenazoxonium chloride: 590 in EtOH with trace of HCl (303).

$C_{20}H_{19}N_2O(Cl)$.—3-Diethylaminonaphthophenazoxonium chloride: 622.3, 573.3, 532.1 in H_2O ; 625.2, 575.7, 533.9 in EtOH; 631.1,

$C_{20}H_{19}N_2O(Cl)$.—(Continued)
 579.5, 537 in AmOH (155); cf. (183); chlorate in EtOH with trace HCl, 629, 585, 539 (303).
 $C_{20}H_{19}N_2O(ClO_4)$.—3-Diethylaminoisonaphthophenazonium perchlorate: 625, 580 in EtOH with trace HCl (303).
 $C_{20}H_{19}N_3O$.—3-Diethylamino-6-aminonaphthophenazoxine: 525 in abs. EtOH (303).
 $C_{20}H_{20}N_3O(Cl)$.—3, 6-Tetramethyldiaminonaphthophenazonium chloride (C. I. 911): 662.2, 603.5 in H₂O; 656.3 in EtOH; 652.6 in AmOH (155).
 3-Dimethylamino-6-ethylaminonaphthophenazonium chloride: 641.8, 587 in H₂O; 634.1 in EtOH; 633.7 in AmOH (155).
 3-Diethylamino-6-aminonaphthophenazonium chloride: 643.5, 592 in H₂O; 630.4 in EtOH; 629.4 in AmOH (155); polyacidic salts (303); influence of concn. (269). (The sulfate is Nile Blue A, C. I. 913. Nile Blue A-azodimethylaniline has max. abs. at 582 (111).)
 $C_{20}H_{26}N_3O(Cl)$.—3, 6-Tetraethyldiaminophenazonium chloride: 654.6, 597.4 in H₂O; 646.9, 624, 592.2 in EtOH; 649, 626.1, 593.5 in AmOH (155).
 $C_{21}H_{20}N_3O(Cl)$.—3-Phenylaminopheno-6-dimethylamino-*o*-tolazonium chloride: 656.3 in H₂O; 658.1 in EtOH or AmOH (155).
 $C_{22}H_{21}N_3O_2$.—3-Diethylamino-6-acetylaminoisonaphthophenazoxine: 560 in abs. EtOH (303).
 $C_{22}H_{22}N_3O_2(Cl)$.—3-Diethylamino-6-acetylaminoisonaphthophenazonium chloride: 662, 602 in EtOH with trace HCl (303).
 3-Diethylamino-9-acetylaminoisonaphthophenazonium chloride: 596 in EtOH with trace HCl (303).
 $C_{24}H_{18}N_3O(Cl)$.—*sym*.-3, 6-Diphenyldiaminophenazonium chloride: 664, 285, 265 in EtOH (313).
 $C_{24}H_{20}N_3O(Cl)$.—3-Dimethylamino-9-phenylaminonaphthophenazonium chloride: 605.5, 555.9, 518.6 in H₂O; 585.7, 545.5 in EtOH; 585, 543.5 in AmOH (155).
 3-Dimethylamino-6-phenylaminonaphthophenazonium chloride: 645 in EtOH with trace HCl (303).
 $C_{24}H_{28}N_3O(Cl)$.—3, 6-Tetraethyldiaminonaphthophenazonium chloride: 671.4, 615.3 in H₂O; 671.4 in EtOH; 674.6 in AmOH (155).
 $C_{25}H_{22}N_3O(Cl)$.—3-Dimethylamino-6-*p*-tolylaminonaphthophenazonium chloride: 670, 600 in H₂O; 670 in EtOH (183).
 $C_{26}H_{22}N_4O_2(Cl)_2$.—Di-Meldola's Blue: 702 (111).
 $C_{26}H_{24}N_3O(Cl)$.—3-Diethylamino-6-phenylaminonaphthophenazonium chloride: triacid salt, 582 (303).
 $C_{27}H_{26}N_3O(Cl)$.—3-Diethylamino-6-*p*-tolylaminonaphthophenazonium chloride: 670, 615 in H₂O; 670 in EtOH (183).
 3-Diethylamino-6-benzylaminonaphthophenazonium chloride (C. I. 914): 592 in H₂O (concd.), 650 (dil.) (269).
 $C_{32}H_{28}N_3O$.—3-Diethylamino-6-diphenylaminonaphthophenazoxine: 550 in abs. EtOH (303).

TABLE 9.—THIAZINE DERIVATIVES

$C_{12}H_6Cl_4NS$.—Tetrachlorothiodiphenylamine: 596 in H₂SO₄ (625).
 $C_{12}H_6N_4O_6S$.—1, 3, 6-Trinitrothiodiphenylamine: 667 in alk. EtOH (304).
 $C_{12}H_7Cl_2NS$.—Dichlorothiodiphenylamine: 569 in H₂SO₄ (625).
 $C_{12}H_7NOS$.—3-Oxythiazine (Thiazone): 543 in H₂O; (acid salts) (529).
 $C_{12}H_7NO_2S$.—6-Hydroxythiazone (Thionol): 584.5, 544.5 in H₂O; 594.8, 558 with alkali; 607.2, 596, 579, 554.8 with alk. EtOH (155); cf. (465).
 $C_{12}H_7N_3O_4S$.—1, 3-Dinitrothiodiphenylamine: (595), 520 in alk. EtOH (304).

3, 6-Dinitrothiodiphenylamine: 492 in alk. EtOH (304).
 $C_{12}H_8CINS$.—Chlorothiodiphenylamine: 544 in H₂SO₄ (625).
 $C_{12}H_8N_2O_2S$.—3-Nitrothiodiphenylamine: 703, 641, 589 in alk. EtOH (304).
 $C_{12}H_8N_2OS$.—3-Hydroxy-6-aminothiazine (Thionoline): 592.2, 547.5 in H₂O; 595.3, 580, 552.6 in EtOH (155); cf. (5, 42).
 $C_{12}H_8NS$.—Thiazine: acid salt, 518, 435; diacid salt, 520, 460, 290 (H₂SO₄) (313); cf. (309, 323).
 $C_{12}H_9NS$.—Thiodiphenylamine: 520, 478, 461 in H₂SO₄ (Ber. 27: 3321; 94).
 $C_{12}H_9N_2S$.—1-Aminothiazine: acid salt, 410, 290 in acid EtOH; diacid salt, 540, 440, 290 (H₂SO₄) (313); cf. (309).
 3-Aminothiazine (Thiazine): chloride, 598.5, 554.8, 516 in H₂O; 593, 548.5, 511.2 in EtOH (155); 292 (H₂O) (311); diacid salt, 470 (H₂SO₄) (309); cf. (42, 323, 529).
 $C_{12}H_{10}N_2S$.—Aminothiodiphenylamine: 555.9, 515.2 in H₂O (153).
 $C_{12}H_{10}N_3S(Cl)$.—1, 3-Diaminodiphenazthionium chloride: 486, 310 in dil. H₂SO₄ (309).
 2, 7-Diaminodiphenazthionium chloride: 535 (42); 532 (625).
 3, 6-Diaminodiphenazthionium chloride (Thionine, C. I. 920); 602.5, 559.4 in H₂O; 605.3, 588.3 in EtOH (155); 284 in H₂O (309); triacid salt, 470 (H₂SO₄) (309); influence of temp. (57); influence of concn. (269); cf. (5, 42, 111, 307, 465, 529q).
 $C_{13}H_{11}N_2S(ClO_4)$.—3-Methylaminodiphenazthionium perchlorate: 596, 553, (514), 290 in acid EtOH (311).
 $C_{13}H_{11}NOS$.—*N*-Methylthiodiphenylamine sulfoxide: acid salt, 515; diacid salt, 460 (H₂SO₄) (313).
 $C_{13}H_{12}N_3S(Cl)$.—Methylthionine chloride: 611.4, 568.2 in H₂O; 614.7, 598.5, 567 in EtOH (155).
 3, 6-Diaminopheno-*o*-tolazthionium chloride: 604.4, 562.5 in H₂O; 607.2, 590.9 in EtOH (155).
 3, 6-Diaminopheno-*m*-tolazthionium chloride: 592 in H₂O (153); 604.4, 587.5 in EtOH (155).
 $C_{14}H_8Br_4N_2OS$.—Tetrabromomethylene violet: 580, 536 in C₆H₅CH₃; 590, 557 in C₆H₅NO₂; 612 in H₂SO₄; 551, 596 in HOAc; 600, 557 in AmOH (625, 580 with KOEt) (182).
 $C_{14}H_{11}N_2OS(Cl)$.—3-Acetaminodiphenazthionium chloride: 556, 458 in H₂O (529).
 $C_{14}H_{12}NS$.—3, 6-Dimethylthiazine: holo- and meriquinoid salts; visible and ultra-violet spectrum of sulfate (323); visible spectrum of chloride (529).
 $C_{14}H_{13}N_2S(ClO_4)$.—3-Dimethylaminodiphenazthionium perchlorate: 635, 586, (536), 293 in EtOH (311).
 $C_{14}H_{13}N_2OS(Cl)$.—Dimethylthionoline chloride (Bernthsen's Methylene Violet): 622.3, 573.2 in H₂O; 601.6, 558.1 in EtOH (155); cf. (5, 42).
 $C_{14}H_{14}N_3S(Cl)$.—*sym*.-Dimethylthionine chloride: 620.1, 574.5 in H₂O; 617.8, 572 in EtOH (155); cf. (5).
asym.-Dimethylthionine chloride (Azure A): 638, 587 in H₂O; 630.1, 579.5 in EtOH (155); cf. (307); influence of temp. (57).
 Ethylthionine chloride: 612.2, 570.7 in H₂O; 617.1, 600.7, 569.5 in EtOH (155).
 $C_{15}H_{16}N_3S(Cl)$.—*asym*.-Dimethyldiaminopheno-*o*-tolazthionium chloride: 640, 588.3 in H₂O; 630.8, 580.2 in EtOH (155). Toluidine Blue O (C. I. 925): 580 in H₂O (concd.), 635 in H₂O (dil.) (269).
asym.-Dimethyldiaminopheno-*m*-tolazthionium chloride: 627.6, 578.2 in H₂O; 626.5, 630, 579.5 in EtOH (155).
 Trimethylthionine chloride: 651.7, 596.1 in H₂O; 642.4, 588.3 in EtOH (155); cf. (277).
 $C_{16}H_{14}N_3O_2S(Cl)$.—Diacylthionine chloride: 535 in H₂O (529).
 $C_{16}H_{17}INS(I)$.—Iodomethylene blue iodide: 661.4, 610.9 in H₂O; 659.2, 610.2 in EtOH (180).
 $C_{16}H_{17}N_2S(Br)$.—3-Diethylaminodiphenazthionium bromide: 638, 589, (540), 293 in acid EtOH (311).

$C_{16}H_{17}N_2OS(Cl)$.—Diethylthionine chloride: 625.5, 577 in H_2O ; 607.2, 561.8 in EtOH (155).

$C_{16}H_{17}N_4O_2S(Cl)$.—Nitromethylene blue: 658, 606, (470), 280 in H_2O ; 400, 300 in 90% H_2SO_4 (309). Methylene Green B (C. I. 924): 665 on cotton (627); influence of concn. (269).

$C_{16}H_{18}N_3S(Cl)$.—*sym.*-Diethylthionine chloride: 621.6, 575.7 in H_2O ; 619.2, 573.2 in EtOH (155); *cf.* (5).

asym.-Diethylthionine chloride: 641, 590.9 in H_2O ; 633.7, 582 in EtOH (155); *cf.* (181).

Tetramethylthionine chloride (Methylene Blue, C. I. 922): 667.5, 608.4 in H_2O ; 657.4, 602.1 in EtOH (155); ultra-violet bands, 290, 243 in EtOH (302); influence of temp. (57, 426); influence of acidity (276, 309); influence of concn. and solvent (269, 276); lakes (265); dyeings (522); solid dye (269); dye base, 527 in $CHCl_3$ (677); *cf.* (5, 161q, 277q, 299q, 307, 581).

$C_{16}H_{19}N_4S(I)$.—Aminomethylene blue iodide: 647.5, 578 in AmOH (180); *cf.* (309).

$C_{17}H_{20}N_3S(Cl)$.—Trimethylethylthionine chloride (C. I. 926): 668.5, 609.9 in H_2O ; 658.1, 603 in EtOH (155).

Diethylmethylthionine chloride: 655, 600.2 in H_2O ; 645.1, 590.9 in EtOH (155).

Diethylaminophenoamino-*o*-tolazthionium chloride: 643.2, 593.5 in H_2O ; 634.7, 583.2 in EtOH (155).

Diethylaminophenoamino-*m*-tolazthionium chloride: 630, 582 in H_2O ; 630.1, 607.5, 582 in EtOH (155).

$C_{18}H_{13}N_2S(Cl)$.—3-Phenylaminodiphenazthionium chloride: 592, (428) in H_2O (529); 626, 572, 290 in acid EtOH (311).

$C_{18}H_{14}N_3S(NO_3)$.—Phenylthionine nitrate: 625, 290 in acid EtOH (302).

$C_{18}H_{22}N_3S(Cl)$.—Triethylthionine chloride: 655.9, 601.6 in H_2O ; 646.5, 592.2 in EtOH (155).

sym.-Diethyldimethylthionine chloride: 672.2 in H_2O ; 659.9 in EtOH; 658.9 in $CHCl_3$; 668.5 in CS_2 ; influence of temp. (57).

asym.-Diethyldimethylthionine chloride: 670, 611.4 in H_2O ; 659.2, 604.1 in EtOH (155); influence of temp. (57); *cf.* (5).

Diethyldiaminodi-*o*-tolazthionium chloride (C. I. 927): New Methylene Blue, 575 in H_2O (concd.), 630 (dil.) (269); on cotton, 610 (627).

$C_{19}H_{16}N_2S(Br)$.—3-Phenylmethylaminodiphenazthionium bromide: 637, 607, (539), 296 in acid EtOH (311).

$C_{19}H_{16}N_3S(Cl)$.—*asym.*-Phenylmethylthionine chloride: 627, 288 in acid EtOH (302).

$C_{19}H_{24}N_3S(Cl)$.—Methyltriethylthionine chloride: 671.5, 612.9 in H_2O ; 660.2, 604.7 in EtOH (155).

Diethylaminophenoethylamino-*o*-tolazthionium chloride: 658.9, 605.8 in H_2O ; 647.2, 592.7 in EtOH (155).

$C_{20}H_{25}BrN_3S(Br)$.—Bromotetraethylthionine bromide: 670, 624 in H_2O ; 676, 614.8 with KOH (181).

$C_{20}H_{26}N_4O_2S(Br)$.—Nitrotetraethylthionine bromide: 639.7 in H_2O ; 672 in EtOH (181).

$C_{20}H_{26}N_3S(Cl)$.—Tetraethylthionine chloride: 673, 614.3 in H_2O ; 661.1, 605.5 in EtOH (155); 664.7 in $CHCl_3$; 667.4 in CS_2 ; influence of temp. (57).

$C_{20}H_{27}N_4S(Br)$.—Aminotetraethylthionine bromide: 623.8 in EtOH (181).

$C_{21}H_{20}N_3S(NO_3)$.—Phenyltrimethylthionine nitrate: 645, 290 in EtOH (302).

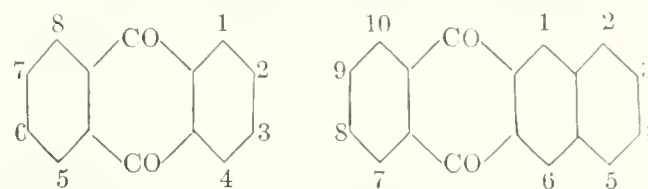
$C_{24}H_{18}N_3S(Cl)$.—*sym.*-Diphenylthionine chloride: 700, 290 in acid EtOH (302).

$C_{26}H_{22}N_3S(Cl)$.—*sym.*-Diphenyldimethylthionine chloride: 670, 290 (302).

$C_{28}H_{26}N_7S(OH)$.—Thioninedisazo-*bis*-dimethylaniline: 505 (111).

"Methylene Azure:" (42, 57, 581).

TABLE 10.—ANTHRAQUINONE DERIVATIVES



Abbreviations: S. B. A. = sulfuric-boric acid; B. A. A. = boric acid-acetic anhydride

$C_{14}H_5Br_3O_5$.—Tribromoflavopurpurin: 537.4, 498.4 in dil. H_2SO_4 (350).

$C_{14}H_6Br_3O_6$.—Tribromohydroxyanthrapurpurin: 570, 532 in alk. H_2O ; 548, 506, 474 in H_2SO_4 ; 557, 516 in S. B. A. (101).

$C_{14}H_6Br_2O_4$.—Dibromoquinizarin: 605, 570 in dil. KOH; 555, 518 in H_2SO_4 (107); 578, 534 in B. A. A. (103).

$C_{14}H_7BrO_4$.—3-Bromoalizarin: 515, 481.5 in H_2SO_4 (350). 2-Bromoquinizarin: 603, 565 in dil. KOH; 553, 515 in H_2SO_4 (107); 570, 530 in B. A. A. (103).

$C_{14}H_7BrO_5$.—Bromopurpurin: 524.7, 492.4 in H_2SO_4 (350). $C_{14}H_7ClO_4$.—2-Chloroquinizarin: 565, 528 in B. A. A. (103); 601 in alk. H_2O (467).

$C_{14}H_7FO_4$.—2-Fluoroquinizarin: 560, 522 in B. A. A. (103). $C_{14}H_7NO_6$.—3-Nitroalizarin (C. I. 1033): 518.3, 490.4 in H_2SO_4 (350); 577.7, 533.7, 494 in alk. H_2O (155).

4-Nitroalizarin (C. I. 1031): 601.9, 557, 519.5 in alk. H_2O ; 564.7, 525.8 in EtOH (609.6, 564.7, 526.7 with alkali) (155).

$C_{14}H_7NO_7$.—Nitroflavopurpurin: 525.1, 493.4 in dil. H_2SO_4 (350).

$C_{14}H_8O_2$.—Anthraquinone: 412, 310, 265 in H_2SO_4 (443). $C_{14}H_8O_3$.—1-Hydroxyanthraquinone: 570.4, 522.9, 495 in $CHCl_3$; 570, 515.9, 495 in EtOH; 551.6 in H_2SO_4 (350); 475, 305, 262 in H_2SO_4 (443); 500, 480 with excess alkali (474); *cf.* (431, 457).

2-Hydroxyanthraquinone: 500, 410, 320, 288 in H_2SO_4 ; alkali salt, 492, 300, 238 in H_2O (443); 495, 470 with excess alkali (474); *cf.* (457).

$C_{14}H_8O_4$.—1, 2, Dihydroxyanthraquinone (Alizarin, C. I. 1027): in H_2SO_4 , 605.4, 493.1 (351); (540.5), 497, 464 (155); 625, 501, 316, 270 (443); *cf.* (350, 379, 430); in S. B. A. (617.5), (569.5), 500, 466.3 (155); in EtOH, 455, (286), 247 (394); with excess alkali in H_2O , 610.8, 566.5, 527.6; in EtOH, 624.9, 578.2, 537.1 (155); *cf.* (443, 474); alkali salt, 527, 330, 260; on mordants, Sn, 473, Al, 507, Cr, 528 (431); absorption in solid and vapor form (336).

1, 4-Dihydroxyanthraquinone (Quinizarin, C. I. 1028): in EtOH, 516, 502.1, 484.4, 468.8, 453.9 (155); *cf.* (430, 431); 314, 279, 244 (394); in H_2SO_4 , 548.3, 509.6, 476.4 (155); *cf.* (351, 379, 430); 325, 272 (443); in S. B. A., 547.5, 508.8, 475.5 (155); in B. A. A., 558, 520 (103); *cf.* (105); in vapor form, 513.7, 504, 492.6, 481.5, 473.6, 463.5 (430); with excess alkali in EtOH, 608.1, 565.4, 529.4; in H_2O , 596.1, 553.7, 517.7 (155); *cf.* (430, 431, 443, 474); on mordants, Sn, (546), 492, Al, 575, 528, Cr, 587, (537) (431).

1, 5-Dihydroxyanthraquinone (Anthrarufin, C. I. 1029): in H_2SO_4 , 570.7, 557.7, 528.5, 517.7, 487.1 (155); *cf.* (350); 320, 272 (443); in S. B. A., 570.7, 550, 528.2, 515.2, 491.3, (459.5) (155); in B. A. A., 570, 527 (105); with excess alkali, 500, 470 (474); *cf.* (443).

1, 7-Dihydroxyanthraquinone: 501.4 in H_2SO_4 (350).

1, 8-Dihydroxyanthraquinone (Chrysazin, C. I. 1030): 533, 495.6, 465.9 in H_2SO_4 ; 533.9, 496.5, 466.9 in S. B. A. (155); 597.9, 538 (350).

2, 3-Dihydroxyanthraquinone (Hystazarin): 619.8, 587.4 in dil. NaOH (351).

2, 6-Dihydroxyanthraquinone (Anthraflavin): 495, 462.6 in H_2SO_4 (351); *cf.* (350, 379); 293 (443); alkali salt, 500, 406, 338, 290 in H_2O (443); with excess alkali, 485, 430, 400 (474).

$C_{14}H_8O_4$.—2, 7-Dihydroxyanthraquinone (Isoanthraflavin): 539.7, 493.6 in H_2SO_4 (350); cf. (379); 303 (443); alkali salt, 505, 394, 343, 305 in H_2O (443); with excess alkali, 500, 475, 390 (474).

$C_{14}H_8O_5$.—1, 2, 3-Trihydroxyanthraquinone (Anthragallol, C. I. 1035): in H_2SO_4 , 575, 525.6, 486.4, 456.6 (155); cf. (156, 350, 379, 430); also 291 (443); in S. B. A., 522.5, 486.5, 455 (band at 578 due to by-product) (156); alkali salt (620), 509, 428, 288 (443).

1, 2, 4-Trihydroxyanthraquinone (Purpurin, C. I. 1037): in H_2SO_4 , 559.9, 520.4, 489.2 (155); cf. (350, 430); (320), 280 (443); in S. B. A., 559.9, 520.4, 489.2 (155); in EtOH, 521.1, 485.5, 455.5 (155); cf. (430, 431); in vapor form, 525.6, 504.5 (430); alkali salt, 546.7, 508.9, 477.7 (155); cf. (430, 431); 275 (443); in alk. EtOH, 550.7, 512.8, 481.5 (155); on mordants: Sn, 538, 512, Al, 553, 520, Cr, 564, 530 (431).

1, 2, 5-Trihydroxyanthraquinone (Brilliant Alizarin Bordeaux R, C. I. 1038): in H_2SO_4 , 640, 573.2, 530, 501 (430); cf. (155, 350); in S. B. A., 640.4, 587, 512.8 (155); in EtOH, (523.8), 470; in vapor form, 513.5, 505, 489.6, 480.5, 469.3 (430); with excess alkali, 619.5, 573.2, 533.5 in H_2O ; 631.5, 583, 541.1 in EtOH (155); cf. (430).

1, 2, 6-Trihydroxyanthraquinone (Flavopurpurin, C. I. 1039): in H_2SO_4 , 531.2, 490.2, 457.8 (155); cf. (351); in dil. H_2SO_4 , 533.5, 495.4 (350); cf. (379); in S. B. A., 534.8, 492.3, (456.6) (155); in excess alkali, 594.8, 551, 512.8 in H_2O (155); cf. (351); 601, 557, 518.5 in EtOH (351).

1, 2, 7-Trihydroxyanthraquinone (Anthrapurpurin, C. I. 1040): in H_2SO_4 , 548.5, 508.8, 478.3 (155); cf. (350); in S. B. A., 687, 512.6, 479.3, 448.9; with excess alkali, 605.8, 561.8, 523 in H_2O ; 610.8, 567, 527.6 in EtOH (155).

1, 2, 8-Trihydroxyanthraquinone: in H_2SO_4 , 549.5, 510, 478.3; in S. B. A., 594.3, 548.9, 514.4; in alk. H_2O , 618, 570.7, 534, 498.5; in alk. EtOH, 631.1, 583, 540.5, 505.5 (155).

1, 4, 5-Trihydroxyanthraquinone: 584.2, 539.1, 497.7 in H_2SO_4 ; 595.6, 550.5, 511.3 in S. B. A.; 526.7, 512.8, 492.5, 478.9, 462 in EtOH (611.7, 560.7, 521.3 with alkali); 598.8, 553.7, 516.3 in alk. H_2O (155).

1, 4, 6-Trihydroxyanthraquinone: 587, 554, 515 in H_2SO_4 ; 561, 513 in S. B. A.; 591, 553 in alk. H_2O (101).

$C_{14}H_8O_5S$.—1-Sulfoanthraquinone: 385, 340 in alk. H_2O (474).

$C_{14}H_8O_6$.—1, 2, 5, 8-Tetrahydroxyanthraquinone (Quinalizarin, C. I. 1045): 637.7, 573.2, 530.3, 492 in H_2SO_4 ; 635.4, 590.9 in S. B. A.; 530.7, 517.0, 490.2, 461.4 in EtOH; (649.7, 634.1), 590.1, 546.5 with alkali; 587.0, 543.5, (506.4) in alk. H_2O (155); cf. (350, 431); on mordants: Sn, 510; Al, 542; Cr, 548 (431).

Oxyflavopurpurin; 523, 490 in H_2SO_4 ; 534, 494 in S. B. A.; 541, 501 in alk. H_2O (101).

Oxyanthrapurpurin; 587, 534, 500, 467 in H_2SO_4 ; 590, 489, 469 in S. B. A.; 561, 521, 489 in alk. H_2O (101).

1, 3, 5, 7-Tetrahydroxyanthraquinone (Anthrachrysone): 508.3, 471.7 in H_2SO_4 (350).

1, 4, 5, 8-Tetrahydroxyanthraquinone: 636.4, 617.1, 584.2, 539.9, 526.2 in H_2SO_4 ; 637.7, 618.3, 585.5, 568.7, 541.1, 527.4 in S. B. A.; 558, 543.9, 519.7, 507.1, 485.6, 475.1 in EtOH; 620.7, 574, 533.9 in alk. H_2O (155).

2, 4, 6, 8-Tetrahydroxyanthraquinone: 504.8, 472 in H_2O ; 512.8, 478.3 in S. B. A.; 449.5 in EtOH; (541) in alk. H_2O (155).

$C_{14}H_8O_7$.—1, 2, 4, 5, 8-Pentahydroxyanthraquinone (Alizarin Cyanin, C. I. 1050): 633.2, 583, 538.5 in H_2SO_4 ; 629.8, 577, 532.5 in S. B. A.; 559.2, 545.3, 520.2, 507.7, 485.9, 475.5 in EtOH (587, 543.9, 507.4 with alkali); 581.7, 538.7, 520.4 in alk. H_2O (155); on mordants: Sn, 555; Al, 584; Cr, 592 (431); in organic solvents (430).

$C_{14}H_8O_8$.—1, 2, 3, 5, 6, 7-Hexahydroxyanthraquinone (Rufgallol, C. I. 1052): 576.5, 531.9 in H_2SO_4 (351); cf. (350, 379); 572.5, 530.3, 457, (432) in H_2SO_4 ; 576.2, 534 in S. B. A. (155); 443 in EtOH (431); on mordants: Sn, 478; Al, 496; Cr, 510 (431).

1, 2, 4, 5, 6, 8-Hexahydroxyanthraquinone (C. I. 1062): 603, 588.3, 555.9, 542.5, 513.6 in H_2SO_4 ; 599.7, 550.7, 506.4 in S. B. A.; 546.3, 533.5, 521.3, 508.7, 496.9, 486.7, 475.9, 465.5 in EtOH (155).

1, 2, 4, 5, 7, 8-Hexahydroxyanthraquinone (C. I. 1064): (661.5), 584.3, 540.5, 502.4 in H_2SO_4 ; 649.5, 593.5, 546.5, 506.4 in S. B. A.; (611), 568.2, 550.5, 527.8, 512, 492.3, 480 in EtOH (155).

1, 3, 4, 5, 7, 8-Hexahydroxyanthraquinone: (675), 604.4, 556.4, 519 in H_2SO_4 ; 565.5, 548.7, 534.8, 508.9, 499.5, (487.5) in EtOH (430); cf. (431); on mordants: Sn, 550; Al, 592; Cr, 600 (431).

$C_{14}H_8O_8S_2$.—1, 5-Disulfoanthraquinone: 420, 333 in alk. H_2O (474).

$C_{14}H_9NO_3$.—1-Hydroxy-4-aminoanthraquinone: 562.5, 522.2 in H_2SO_4 ; 571.2, 528.3, 486, 455 in S. B. A.; 570.2, 529.4, 493 in EtOH (602.7, 559.4, 521.7 with alkali); 590.7, 548.5, 511.2 in alk. H_2O (155).

$C_{14}H_9NO_4$.—1, 2-Dihydroxy-4-aminoanthraquinone (C. I. 1032): 560.3, 515.2, 485 in H_2SO_4 ; 569.5, 526.7, 489 in S. B. A.; 564, 523.5, 488.5 in EtOH (567.7, 527.6, 491.7 with alkali); 559.2, 519.9, 486.4 in alk. H_2O (155); (531.3, 495.2 in H_2SO_4 (350)).

394, 343, 305 1, 2-Dihydroxy-3-aminoanthraquinone: 540.3, 499.4 in H_2SO_4 (350).

2, 4-Dihydroxy-1-aminoanthraquinone: 550.9, 510.5, 480.5, 450 in H_2SO_4 ; 552.6, 511.7, 477, 448 in S. B. A.; 552.8, 515.2, 482.5 in EtOH (555.5, 520.6, 487.8 with alkali); 545.9, 510.4, 480.7 in alk. H_2O (155).

$C_{14}H_{10}N_2O_2$.—1, 4-Diaminoanthraquinone (584.5, 568.2), (537.3, 526.7), (497, 492.4) in S. B. A.; 595.6, 551.3, 512.7 in EtOH (155).

$C_{14}H_{10}N_2O_4$.—1, 5-Dihydroxy-4, 8-diaminoanthraquinone: 617.7, 568, 523 in H_2SO_4 ; (626.1, 609.9), (577.7, 562.9), (536, 524), in EtOH (641.4, 591, 547.5 with alkali) (155).

$C_{14}H_{12}N_4O_2$.—1, 4, 5, 8-Tetraaminoanthraquinone: 576, 531.5, 507.5 in S. B. A.; 638.7, 590.4, 549.3 in EtOH (625.5, 578.2, 536.6 with acid) (155).

$C_{15}H_7Br_3O_6$.—Tribromococcin: 556, 514, 482 in H_2SO_4 ; 570, 528 in S. B. A.; 581, 538 in alk. H_2O (101).

$C_{15}H_8O_7$.—Purpurincarboxylic acid (pseudopurpurin): 563.5, 520.8, 489.8 in H_2SO_4 (350).

$C_{15}H_9BrO_6$.—2-Methoxy-3-bromoquinizarin: 520, 485 in H_2SO_4 ; 540, 505 in S. B. A.; 540, 505 in dil. KOH (107).

$C_{15}H_{10}O_3$.—1-Hydroxy-4-methylanthraquinone: 555.2 in H_2SO_4 ; 523.5 in $CHCl_3$ (350).

$C_{15}H_{10}O_4$.—1, 8-Dihydroxy-3-methylanthraquinone: 604.8, 534.4, 499.2 in H_2SO_4 (350).

$C_{15}H_{10}O_5$.—Methylhydroxylizarin: 607.2, 569.4, (519.7) in H_2SO_4 (350).

α -Methylanthragallol: 541.5, 502.4 in H_2SO_4 (350).

1, 4, 6-Trihydroxy-8-methylanthraquinone: 580, 524, 486 in H_2SO_4 ; 579, 527, 486 in S. B. A.; 595, 532 in alk. H_2O (101).

1, 5, 8-Trihydroxy-2-methylanthraquinone: 459 in EtOH + HCl; 517 in EtOH + NaOH (195).

1, 5, 8-Trihydroxy-3-methylanthraquinone: 487 in EtOH + HCl; 557 in EtOH + NaOH (195).

1, 5, 8-Trihydroxy-4-methylanthraquinone: 478 in EtOH + HCl; 520 in EtOH + NaOH (195).

2, 5, 8-Trihydroxy-1-methylanthraquinone: 468 in EtOH + HCl; 532 in EtOH + NaOH (195).

$C_{15}H_{10}O_6$.—Methyltetrahydroxyanthraquinone: 540, 501 in H_2SO_4 ; 546, 503 in S. B. A.; 539, 501 in alk. H_2O (101).

$C_{16}H_{12}O_4$.—Dimethylanthrarufin: 569.4, 520.8 in H_2SO_4 (350). Alizarin dimethyl ether: 597.6, 487.5 in H_2SO_4 (351); cf. (379).

Quinizarin dimethyl ether: 564.4, 519.8, (484.3) in H_2SO_4 ; 577.4, 535.4, 494.1 in neutral soln. (351); cf. (379).

Anthraflavin dimethyl ether: 501.5, 472.6, (436.9) in H_2SO_4 (351); cf. (379).

$C_{16}H_{12}O_5$.—Dimethylanthragallol: 544.3, 507.5 in H_2SO_4 (350). Anthragallol ethyl ether: 515 in H_2SO_4 (351); cf. (379).

$C_{16}H_{12}O_6$.—Dimethyltetrahydroxyanthraquinone (probably 1, 5-dimethylanthrachrysone): 635.3, 617.8, 582.4, 540.3 in H_2SO_4 (350).

$C_{16}H_{14}N_2O_2$.—1, 4-Dimethylaminoanthraquinone: (624.9, 602.5), (572.0, 552.8), (526.7, 509.6) in S. B. A.; 644.5, 595.1, 550.5 in EtOH (155).

$C_{17}H_9NO_4$.—1, 2-Dihydroxyanthraquinone- α -quinoline (C. I. 1068): 597.7, 551.5, 516.8, 487.8 in H_2SO_4 ; 660, 603 in S. B. A.; 588.8, 545.5, 507.2 in EtOH; 578.3, 535.3, 497.3 in H_2O ; 567.5, 526.9, 491.9 in alk. H_2O ; 576, 530.5, 494.7 in alk. EtOH (155).

1, 2-Dihydroxyanthraquinone- β -quinoline (C. I. 1066): 604.4, 560.7, 524, 492.7 in H_2SO_4 ; 578 in S. B. A.; 675, 617.7, (579.5) in alk. H_2O ; 690.6, 632.1, 580.7 in alk. EtOH (155). Alizarin Blue: on wool (10); infra-red bands at 0.8 and 1.0μ with strong band at 0.5μ in EtOH (388).

$C_{17}H_{14}O_6$.—Trimethylantragallol: 554.1, 507.5 in H_2SO_4 (350).

1-Hydroxy-2-methyl-5, 8-dimethoxyanthraquinone: 460 in EtOH + HCl; 507 in EtOH + NaOH (195).

1-Hydroxy-3-methyl-5, 8-dimethoxyanthraquinone: 473 in EtOH + HCl; 525 in EtOH + NaOH (195).

1-Hydroxy-4-methyl-5, 8-dimethoxyanthraquinone: 467 in EtOH + HCl; 506 in EtOH + NaOH (195).

$C_{18}H_{16}O_4$.—Quinizarin diethyl ether: 577, 535, (494) in H_2SO_4 (379).

Anthraflavin diethyl ether: 504.5, 477.5, (439.8) in H_2SO_4 (351); cf. (379).

Isoanthraflavin diethyl ether: 505.1, 492.3 in H_2SO_4 (351); cf. (379).

$C_{18}H_{16}O_5$.—Anthragallol diethyl ether: 515 in H_2SO_4 (379).

Anthrapurpurin diethyl ether: 508.1 in H_2SO_4 (351).

Flavopurpurin diethyl ether: 542.3, 501.5 in H_2SO_4 (351); cf. (379).

$C_{18}H_8N_2O_7$.—1-Hydroxy-2, 6-dinitronaphthacenequinone: 416 in EtOH (521, 408 with NaOEt) (41).

$C_{18}H_9ClO_3$.—1-Chloro-6-hydroxynaphthacenequinone: 571, 523, 304 in S. B. A.; 458, 250 in EtOH (510, 402, 261 with NaOEt) (41).

$C_{18}H_{10}O_3$.—1-Hydroxynaphthacenequinone: 571, 324 in S. B. A.; 455, 249 in EtOH (526, 263 with NaOEt) (41).

$C_{18}H_{10}O_4$.—1, 6-Dihydroxynaphthacenequinone: 540, 492, 463, 331, 294 in S. B. A.; 488, 260 in EtOH (555, 265 with NaOEt) (41).

1, 7-Dihydroxynaphthacenequinone: 613, 571, 297 in S. B. A.; 476 in EtOH (488, 250 with NaOEt) (41).

1, 8-Dihydroxynaphthacenequinone: 571, 323 in S. B. A.; 454, 291 in EtOH (508, 472, 250 with NaOEt) (41).

$C_{18}H_{10}O_6$.—1, 2, 6-Trihydroxynaphthacenequinone: 570, 326 in S. B. A.; 488, 280 in EtOH (513 with NaOEt) (41).

$C_{18}H_{10}O_7S$.—1, 5-Dihydroxynaphthacenequinone-4 (?) -sulfonic acid: 610, 571, 300 in S. B. A.; 488, 260 in EtOH (588 with NaOEt) (41).

$C_{18}H_{11}NO_3$.—1-Amino-6-hydroxynaphthacenequinone: 541, 508, 292 in S. B. A.; 556, 510, 481, 264 in EtOH (562, 264 with NaOEt) (41).

$C_{18}H_{11}NO_4$.—1-Amino-6, 8-dihydroxynaphthacenequinone: 571, 293 in S. B. A.; 556, 513, 477 in EtOH (588, 250 with NaOEt) (41).

$C_{18}H_{12}O_4$.—1-Hydroxy-5-methoxynaphthacenequinone: 700, 300 in S. B. A.; 481, 252 in EtOH (530, 261 with NaOEt) (41).

1-Hydroxy-8-methoxynaphthacenequinone: 571, 327 in S. B. A.; 467, 290 in EtOH (532, 260 with NaOEt) (41).

$C_{20}H_{13}NO_3$.—1-Hydroxy-4-phenylaminoanthraquinone: 585, 540.5 in H_2SO_4 ; 592.7, 546.5, 506.4 in S. B. A.; 588.6, 546.5, 508.3 in EtOH; 631.5, 583.2, 541.1 in alk. EtOH (155).

$C_{20}H_{20}O_5$.—Flavopurpurin triethyl ether: 535.3, (489.5), 468.4 in H_2SO_4 (351).

$C_{20}H_{20}O_8$.—Rufigallol triethyl ether: 579, 544.6 in H_2SO_4 (351); cf. (379).

$C_{21}H_{13}NO_4$.—1-Benzoylamino-4-hydroxyanthraquinone (Algol Pink R, C. I. 1128): 577, 534.5, 489.5 in H_2SO_4 (190); cf. (116); 538, 496 in C_9H_7N (116).

$C_{21}H_{13}NO_6$.—1-Benzoylamino-4, 5, 8-trihydroxyanthraquinone (Algol Violet B, C. I. 1130): 656, 603, 529, 495 in H_2SO_4 ; 637, 559, 523 in C_9H_7N (116); 600, 575 on cotton (522).

$C_{21}H_{14}N_2O_3$.— α -Benzoylhydrazinoanthraquinone: 540, 500, 300, 264 in H_2SO_4 (560, 530 on adding H_3BO_3) (39).

β -Benzoylhydrazinoanthraquinone: 504, 400, 303, 254 in H_2SO_4 (39).

$C_{21}H_{16}NO_3$.—1-Hydroxy-4-*o*-tolylaminoanthraquinone: 586.5, 541.5 in H_2SO_4 ; 591.5, 545.3, 505 in S. B. A.; 583.5, 542, 504 in EtOH (628.2, 579.5, 538 with alkali) (155).

1-Hydroxy-4-*p*-tolylaminoanthraquinone: 587, 542.5 in H_2SO_4 ; 592.2, 545.9, 505.6 in S. B. A.; 587.5, 546.5, (509) in EtOH (632.4, 583.3, 541.5 with alkali) (155).

$C_{22}H_{14}O_6$.—1, 8-Diacetoxynaphthacenequinone: 571, 328 in S. B. A.; 400 in EtOH (476, 382 with NaOEt) (41).

$C_{22}H_{16}NO_4$.—1-Benzoylamino-4-methoxyanthraquinone (Algol Scarlet G, C. I. 1129): 490, 460 in C_9H_7N ; 597, 530, 500 in H_2SO_4 (116).

$C_{24}H_{14}N_2O_6$.—1-Hydroxy-2 (?) -nitro-6 (?) -anilinonaphthacenequinone: 588, 297 in S. B. A.; 610, 575 in EtOH (606 with NaOEt) (41).

$C_{24}H_{16}NO_3$.—1-Anilino-6-hydroxynaphthacenequinone: 556, 293 in S. B. A.; 526 in EtOH (613, 568 with NaOEt) (41).

$C_{26}H_{18}N_2O_2$.—1, 4-Dianilinoanthraquinone: 633.4, 577.5, 533 in H_2SO_4 ; 521.7, (483) in S. B. A.; 642.4, 589.6, 545.5 in EtOH (155).

1, 5-Dianilinoanthraquinone: 533 in solid form; 482 in vapor form (340°) (336).

$C_{28}H_8Cl_4O_2$.—4, 5, 4', 5'-Tetrachloro-*meso*-naphthodianthrone: 610, (564), 518 in H_2SO_4 (113); cf. (437).

$C_{28}H_{10}Br_2O_2$.—3, 3'-Dibromo-*meso*-naphthodianthrone: 550 in H_2SO_4 (113).

$C_{28}H_{10}Cl_2O_2$.—3, 3'-Dichloro-*meso*-naphthodianthrone: 254 in H_2SO_4 (113).

4, 4'-Dichloro-*meso*-naphthodianthrone: 591, 521 in H_2SO_4 (113).

$C_{28}H_{12}Br_2O_2$.—3, 3'-Dibromo-*meso*-benzodianthrone: 640 in H_2SO_4 (113).

$C_{28}H_{12}Cl_2O_2$.—3, 3'-Dichloro-*meso*-benzodianthrone: 645 in H_2SO_4 (113).

$C_{28}H_{12}Cl_4O_2$.—1, 5, 1', 5'-Tetrachlorodianthrone: 546 in H_2SO_4 (113).

4, 5, 4', 5'-Tetrachlorodianthrone: 567 in H_2SO_4 (113).

1, 4, 1', 4'-Tetrachlorodianthrone: 546 in H_2SO_4 (113).

$C_{28}H_{12}O_2$.—*meso*-Naphthodianthrone: 569, 511 in H_2SO_4 (113).

$C_{28}H_{12}N_2O_2$.—Indanthrene Yellow G (C. I. 1118): 484, 454 in C_9H_7N ; 510, 479, 453 in H_2SO_4 (116).

$C_{28}H_{14}Cl_2O_2$.—3, 3'-Dichlorodianthrone: 546, 450 in H_2SO_4 (113).

4, 4'-Dichlorodianthrone: 630, 584 in H_2SO_4 (113).

$C_{28}H_{15}NO_4$.— α , β -Dianthraquinonylamine (Algol Orange R, C. I. 1137): 496 in C_9H_7N (116).

$C_{28}H_{16}O_2$ (?).—Helianthrone: 618, (590) in H_2SO_4 (437).

Dianthrone: 558, (530) in H_2SO_4 (437).

$C_{28}H_{18}N_2O_4$.—1, 4-Dibenzoyldiaminoanthraquinone (Algol Red 5G, C. I. 1131): 541, 502 in C_9H_7N ; 571, 530, 491 in H_2SO_4 (116).

$C_{28}H_{18}N_2O_5$.—1, 5-Dibenzoyldiamino-8-hydroxyanthraquinone (Algol Red R, C. I. 1133): 560.2, (521.4), 488.4 in S. B. A. (190); 562, 524, 492 in C_9H_7N ; 610, 568, 526 in H_2SO_4 (116).

$C_{28}H_{22}N_2O_5S$.—1-*p*-Toluido-4-*o*-sulfo-*p*-toluidoanthraquinone: 649.7, 591 in H_2SO_4 ; 643.8, 586.5, 540.3, 500, 469.5 in S. B. A.; 650.7, 596.1, 552.2 in EtOH (155).

$C_{28}H_{22}N_2O_2$.—1, 4-Di-*o*-toluidoanthraquinone: 634.4, 578.2, 533.4 in H_2SO_4 ; (618, 600.2), (567, 551.5), (523, 512.8) in S. B. A.; 638.7, 585.7, 543.1 in EtOH (155).

1, 4-Di-*p*-toluidoanthraquinone: 632.7, 578.2, 533 in H_2SO_4 ; 618.3, 567, 522.4 in S. B. A.; 644.1, 590.9, 546.5 in EtOH (155).

1, 5-Di-*p*-toluidoanthraquinone: 482 in vapor form (370°) (336).

$C_{29}H_{16}N_2O_6$.—1, 1'-Dianthraquinonylurea: 265 in H_2SO_4 (40).
1, 2'-Dianthraquinonylurea: 260 in H_2SO_4 (40).

2, 2'-Dianthraquinonylurea (C. I. 1138): 410, 270 in H_2SO_4 (40).

$C_{30}H_{12}Br_2O_2$.—Dibromopyranthrene (Indanthrene Scarlet G, C. I. 1098): 509, 478, 449 in C_9H_7N ; 538 in H_2SO_4 (116).

$C_{30}H_{14}O_2$.—Pyranthrene (Indanthrene Gold Orange G, C. I. 1096): 486 in C_9H_7N ; 620, 575, 545, 504 in H_2SO_4 (116); 544.3, 503.5 in vat (190).

$C_{30}H_{16}O_4$.—2, 2'-Dianthraquinonylethylene (Anthraflavone, C. I. 1095): 581, 548 in H_2SO_4 (116).

$C_{30}H_{18}N_2O_4$.—*N*-Dimethylindanthrene (C. I. 1108): Algol Blue K, 700 in xylene (190).

$C_{30}H_{28}N_4O_2$.—Tetramethyl-*p*-diamino-1, 4-dianilinoanthraquinone: 628.8, 575, 530.7 in H_2SO_4 ; 619.5, 568.2, 524 in S. B. A. (155).

$C_{31}H_{18}N_2O_4$.— β -Anthraquinone- α -anthra-*N*-methylpyridone-amine (Algol Red B, C. I. 1155): 555, 521, 488 in C_9H_7N ; 530, 493, 460 in H_2SO_4 (116); 524.8, 490.5, 457.8 in S. B. A. (190).

$C_{34}H_{14}Cl_2O_2$.—Dichloroisoviolanthrene (C. I. 1104): Indanthrene Violet 2R, 594, 545, 505 in C_9H_7N (116).

$C_{34}H_{16}O_2$.—Violanthrene (Indanthrene Dark Blue BO, C. I. 1099): 578.3, 535.6, 500.8 in vat (190); Violanthrene B, 618, 568, 523, 488 in C_9H_7N ; 575, 531, 524 in H_2SO_4 (116).

Isoviolanthrene (Indanthrene Violet R, C. I. 1103): 603, 555, 516, 482 in C_9H_7N ; 520, 490 in H_2SO_4 (116).

$C_{42}H_{20}Cl_2N_2O_6$.—Dichloro-di- α -anthraquinonyl-2, 7-diaminoanthraquinone (Indanthrene Bordeaux B, C. I. 1143): 540, 500 in C_9H_7N ; 580 in H_2SO_4 (116).

$C_{42}H_{22}N_2O_6$.—Di- α -anthraquinonyl-2, 6-diaminoanthraquinone (Indanthrene Red G, C. I. 1140): 641, 587, 543.2, 497.7 in H_2SO_4 (190); 530, 500 in C_9H_7N (116).

2, 7-Di- α -anthraquinonyldiaminoanthraquinone (Indanthrene Red R, C. I. 1142): 520, 500 in C_9H_7N (116); 525 on cotton (522).

$C_{44}H_{26}N_2O_8$.—4, 4'-Dimethoxy-di- α -anthraquinonyl-2, 6-diaminoanthraquinone (Algol Bordeaux 3B, C. I. 1141): 668, 540, 500 in C_9H_7N ; 606, 572 in H_2SO_4 (116); 608.5, 538.5 in S. B. A. (190).

Algol Brown B (C. I. 1166): 581, 536 in C_9H_7N (113).

Algol Corinth (C. I. 1144): 606, 561 in C_9H_7N ; 603, 552 in H_2SO_4 (116).

Algol Gray B (C. I. 1145): 642, 547 in C_9H_7N ; 615, 562 in H_2SO_4 (116).

Alizarin Blue S 5R: 540 in H_2O (coned.), 560 (dil.) (269).

Alizarin Red W: 610, 559, 518 in alk. EtOH (369).

Cibanone Brown B (C. I. 1171): 568, 528, 488 in C_9H_7N ; 581, 543, (493) in H_2SO_4 (116).

Cibanone Brown G: 570, 530, 493 in C_9H_7N ; 581, 530, (490) in H_2SO_4 (116).

Cibanone Yellow R (C. I. 1170): 530.6, 492.6 in H_2SO_4 (190); cf. (116).

Helindone Orange GRN (C. I. 1147): 490 in C_9H_7N (116).

Indanthrene Blue GED: 650 on cotton (522).

Indanthrene Brown B (C. I. 1120): 614, 557 in C_9H_7N (116).

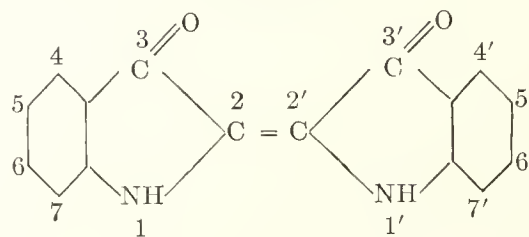
Indanthrene Gray: 530, 490 in C_9H_7N (116).

Indanthrene Maroon R (C. I. 1125): 553, 493 in C_9H_7N (116).

Indanthrene Orange RT (C. I. 1157): 557, 492 in H_2SO_4 (116).

Indanthrene Violet RT (C. I. 1100): 601, 554, 511 in C_9H_7N ; 575, 531, 524 in H_2SO_4 (116); 583.2, 539.7, 500 in xylene (190).

TABLE 11.—INDIGO DERIVATIVES AND RELATED COLORING MATTERS



$C_{13}H_{11}NO_3$.—2-Indole-3-pentanoneindigo: 478 in $CHCl_3$ (254).
 $C_{14}H_{10}N_2O_4S_2$.—Disulfurylindigo: 460, 288 in HOAc; 455 in H_2SO_4 (382).

$C_{15}H_{10}N_2O_3S$.—Sulfurylindigo: 456, 254 in EtOH (633, 288 with alkali); 472 in H_2SO_4 (382).

$C_{16}H_2Br_8N_2O_2$.—Octabromoindigo: 611.5 in xylene; 613.5 in tetralin (154).

$C_{16}H_2Cl_8N_2O_2$.—Octachloroindigo: 606.9, 555.4 in xylene; 604.3, 555.2 in methyl benzoate (191); cf. (194).

$C_{16}H_4Br_6N_2O_2$.—4, 5, 7, 4', 5', 7'-Hexabromoindigo: 616.2 in xylene; 623.6 in $CHCl_3$ (189); 619 in tetralin (154).

$C_{16}H_6Br_6N_2O_2$.—4, 5, 7, 5', 7'-Pentabromoindigo: 615 in xylene; 621.3 in $CHCl_3$ (189); 618 in tetralin (154).

$C_{16}H_6Br_2Cl_2N_2O_2$.—5, 5'-Dibromo-4, 4'-dichloroindigo (C. I. 1189): 612.5 in xylene (191); 631.3 in methyl benzoate (194); 615.5 in tetralin (154).

7, 7'-Dibromo-5, 5'-dichloroindigo: 611.5 in xylene; 614.5 in tetralin (154).

$C_{16}H_6Br_2O_2S_2$.—5, 5'-Dibromothioindigo (C. I. 1208): 555.5, 513.8 in xylene (190); 564, 522, 486, 455 in C_9H_7N (116); 559, 515 in tetralin (154).

6, 6'-Dibromothioindigo: 539.5, 498 in xylene; 541.5, 500 in tetralin (154).

$C_{16}H_6Br_3NO_2S$.—2-(5, 7-Dibromoindole)-5'-bromo-2'-thionaphtheneindigo (C. I. 1222): 598, 557 in C_9H_7N ; 550 in H_2SO_4 (116); 590, 545 in xylene; 592.5, 547.5 in tetralin (154).

2-(4, 5, 7-Tribromoindole)-2'-thionaphtheneindigo: 585.5, 539.5 in xylene; 588, 542 in tetralin (154).

$C_{16}H_6Br_4N_2O_2$.—5, 7, 5', 7'-Tetrabromoindigo (C. I. 1184): 623 in $CHCl_3$ (350); 620 in $C_6H_5NO_2$ (87); 613 in xylene; 616 in tetralin (154); cf. (188, 191). (Ciba Blue 2B reported as 653, 600.5 in xylene (190).)

5, 7, 5', 7'-Tetrabromoindirubin (C. I. 1205): 579.5, 537 in xylene (190); 590, 545 in C_9H_7N ; 580 in H_2SO_4 (116); 613 in xylene; 616 in tetralin (154).

$C_{16}H_6Cl_2O_2S_2$.—4, 4'-Dichlorothioindigo: 545, 503 in xylene; 547.5, 505 in tetralin (154).

5, 5'-Dichlorothioindigo (C. I. 1209): 547.3, 504 in xylene (190); 556, 511 in C_9H_7N (116); 550.5, 507.5 in tetralin (154).

6, 6'-Dichlorothioindigo (C. I. 1210): Ciba Red B, 539, 497.5 in xylene; 541, 499.5 in tetralin. Helindone Rose R, 538, 497 in xylene; 540, 499 in tetralin (154).

$C_{16}H_6Cl_4N_2O_2$.—4, 7, 4', 7'-Tetrachloroindigo: 596.7, 546.8 in xylene; 600.6, 551.7 in methyl benzoate (191).

5, 7, 5', 7'-Tetrachloroindigo (C. I. 1190): 609 in xylene; 616.6 in methyl benzoate (191); cf. (194); 615 in $C_6H_5NO_2$ (87); 613.5 in tetralin (154).

$C_{16}H_7Br_2NO_2S$.—2-(5-Bromoindole)-5'-bromo-2'-thionaphtheneindigo (C. I. 1221): 600, 556 in C_9H_7N (116); 589, 544.5 in xylene; 591.5, 547 in tetralin (154); cf. (190).

3-(5, 7-Dibromoindole)-2'-thionaphtheneindigo (C. I. 1226): 543.5, 502 in xylene; 546, 504 in tetralin (154). Thioindigo Scarlet G, 500 in C_9H_7N ; 580, 500 in H_2SO_4 . Ciba Red G, 530, 500 in C_9H_7N (116).

2-(5, 7-Dibromoindole)-2'-thionaphtheneindigo: 584, 539 in xylene; 580.5, 541.5 in tetralin (154).

$C_{16}H_7Br_3N_2O_2$.—5, 7, 5'-Tribromoindigo: 608.7 in xylene (188); 612.5 in xylene; 615.5 in tetralin (154).

$C_{16}H_7Br_3N_2O_2S$.—Tribromo-3-indole-2'-(6'-aminothionaphthene)-indigo (Helindone Brown G, C. I. 1227): 540 in H_2SO_4 (116).

$C_{16}H_8BrNO_2S$.—2-(5-Bromoindole)-2'-thionaphtheneindigo (C. I. 1220): 582.5, 538.5 in xylene; 585, 541 in tetralin (154). (Ciba Grey G, 598, 548 in C_9H_7N (116).)

$C_{16}H_8Br_2N_2O_2$.—4, 4'-Dibromoindigo: 613 in $C_2H_2Cl_4$ (165).

5, 5'-Dibromoindigo: 621 in $C_2H_2Cl_4$ (165); 605.5 in xylene; 609 in tetralin (154); cf. (188, 350).

6, 6'-Dibromoindigo: 591.6, 536.5 in xylene; 593.5, 554 in methyl benzoate (191); 585 in $C_2H_2Cl_4$ (165); 592, 550 in tetralin (154); cf. (117, 194).

7, 7'-Dibromoindigo: 606 in $C_2H_2Cl_4$ (165).

6, 6'-Dibromoindirubin: 567, 520 in xylene (118).

$C_{16}H_8Br_2N_2O_2S_2$.—5, 5'-Dibromo-6, 6'-diaminothioindigo (C. I. 1215): 519, 484 in xylene; 521, 485.5 in tetralin (154).

$C_{16}H_8Br_4N_4O_2$.—5, 7, 5', 7'-Tetrabromo-6, 6'-diaminoindigo (C. I. 1187): 559, 523 in xylene; 562.5, 526 in tetralin (154); 563.3 in methyl benzoate (194); 585.1 in H_2SO_4 (350).

$C_{16}H_8Cl_2N_2O_2$.—6, 6'-Dichloroindigo: 558.5, 518.5 in xylene; 561, 521 in tetralin (154).

$C_{16}H_8I_2N_2O_2$.—6, 6'-Diiodoindigo: 598, 546.5 in xylene; 600.9, 558.1 in methyl benzoate (194).

$C_{16}H_8N_4O_6$.—5, 5'-Dinitroindigo: 585.5 in $CHCl_3$ (?) (350).

6, 6'-Dinitroindigo: 635.5 in xylene; 638 in tetralin (154).

$C_{16}H_8N_6O_2(Cl)_2$.—Tetrazoindigo chloride: 565, 517 in H_2O (115).

$C_{16}H_8O_2S_2$.—Thioindigo: 543.5, 502 in xylene; 546, 504 in tetralin (154); 547 in $CHCl_3$ (163); 552, 508 in C_9H_7N (116); 407, 310 in H_2SO_4 (382); cf. (111, 167, 169, 190, 524).

$C_{16}H_8O_3S_2$.—Hydroxythioindigo: 539, (497.5) in xylene (88).

Thioindigo sulfoxide: 520 in xylene (524).

$C_{16}H_8O_4S_2$.—5, 5'-Dihydroxythioindigo: 590 in $C_2H_2Cl_4$ (164).

6, 6'-Dihydroxythioindigo: 560, 520 in H_2SO_4 (164).

Thioindigo sulfone: 500 in xylene (524).

$C_{16}H_8O_5S_2$.—Trihydroxythioindigo: 487.7 in xylene (88).

$C_{16}H_9NO_2S$.—2-Indole-2'-thionaphtheneindigo: 575, 531.5 in xylene; 577.5, 533.5 in tetralin (154); 579 in $CHCl_3$ (163); cf. (122).

3-Indole-2'-thionaphtheneindigo (C. I. 1225): 544.5, 507 in xylene; 546, 504 in tetralin (154); 510 in C_9H_7N ; 580 in H_2SO_4 (116); cf. (640).

$C_{16}H_{10}N_2O_2$.—Indigo (C. I. 1177): 630 in $C_6H_5NH_2$ (382); 615.9 in HOAc (117); 604.8 in $CHCl_3$ (350); 590.9 in xylene (117); 601.5 in tetralin (154); 472, 300 in H_2SO_4 (382). (Formánek reports band at 637, Krüss at 605.1); 678 in solid form; 546 in vapor at 320° (336); 650 on cotton (522); cf. (111, 187, 191, 524, 528q, 602q, 669q).

Indirubin: 561, 522 in xylene; 564, 525 in tetralin (154); 544 in HOAc (641); 568, 534 in C_9H_7N (116); 289 in MeOH (108); 492 in vapor form (305°) (336).

Isoindigo: 520, 335, 268 in MeOH (108); 477 in HOAc (641).

$C_{16}H_{10}N_2O_2S_2$.—5, 5'-Diaminothioindigo: 592, 523 (111).

7, 7'-Diaminothioindigo (C. I. 1213): 646 in C_9H_7N ; 584, 550 in H_2SO_4 (116).

$C_{16}H_{10}N_2O_5S$.—Indigo-5-sulfonic acid: K salt, 608 in H_2O ; 615 in 80% EtOH; 525 in solid form (268q).

$C_{16}H_{10}N_2O_8S_2$.—Indigo-5, 5'-disulfonic acid: K salt, 610 in H_2O ; 610 in 80% EtOH (268q); Na salt (C. I. 1180): 612, 289, 252 in H_2O (179q); cf. (115q, 268q, 299q, 390q, 391q, 422q).

$C_{16}H_{10}N_2O_{11}S_3$.—Indigo-5, 7, 5'-trisulfonic acid: K salt, 603 in H_2O ; 605 in 80% EtOH; 560 in solid form (268q).

$C_{16}H_{10}N_2O_{14}S_4$.—Indigo-5, 7, 5', 7'-tetrasulfonic acid: K salt, 590 in H_2O ; 598 in 80% EtOH (268).

$C_{16}H_{11}N_3O_2$.—5-Aminoindigo: 589 (111).

$C_{16}H_{12}N_4O_2$.—4, 4'-Diaminoindigo: 594 (111).

5, 5'-Diaminoindigo: 588.9 in H_2SO_4 (350); hydrochloride, 623 in H_2O (115).

$C_{17}H_9NO_3$.—2-Indanone-2'-indoleindigo: 508 in $CHCl_3$ (122).

$C_{17}H_{10}N_2O_3$.—2-Isoquinolone-2'-indoleindigo: 584 in $CHCl_3$ (122).

$C_{17}H_{10}N_2O_2S$.—5-Isatinyl-3-phenylrhodanic acid: 430 in HOAc (677).

$C_{17}H_{11}BrN_2O_2$.—5-Bromo-7-methylindirubin (C. I. 1206): 582, 538 in xylene; 585, 541 in tetralin (154).

$C_{17}H_{11}NO_2$.—2-Indane-2'-indoleindigo: 492 in $CHCl_3$ (122).

$C_{17}H_{12}N_2O_2$.—N-Methylindigo: 635.5 in xylene; 638.5 in tetralin (154); 639.4 in xylene (117).

5-Methylisoindigo: 491 in HOAc (641).

7-Methylisoindigo: 489 in HOAc (641).

5-Methyl-2-indole-3'-indoleindigo: 535 to 544 in HOAc (641).

7-Methyl-2-indole-3'-indoleindigo: 546 in HOAc (641).

5-Methyl-3-indole-2'-indoleindigo: 544, 532 in HOAc (641).

7-Methyl-3-indole-2'-indoleindigo: 546, 528 in HOAc (641).

$C_{18}H_8Br_2N_2O_3S$.—2-Naphthsultam-2'-(5', 7'-dibromoindole)-indigo: 674, 614 in C_6H_6 (349).

$C_{18}H_9NO_4S_2$.—2-Thionaphthene-2'-naphthsultamquinoneindigo: 590, 545 in $C_6H_5NO_2$ (168).

$C_{18}H_{10}Br_2O_2S_2$.—6, 6'-Dibromo-4, 4'-dimethylthioindigo (C. I. 1211): 542.5, 501 in xylene; 545, 503 in tetralin (154).

$C_{18}H_{10}Cl_2O_2S_2$.—5, 5'-Dichloro-6, 6'-dimethylthioindigo (Helindone Red 3B, C. I. 1212): 562, 520.7 in xylene (190); 575, 530 in C_9H_7N (116); 560, 540 on cotton (522).

5, 5'-Dichloro-7, 7'-dimethylthioindigo: 565, 526 in xylene; 567.5, 528 in tetralin (154).

$C_{18}H_{10}NO_3S$.—2-Naphthsultam-2'-indoleindigo: 655, 605 in EtOH (168); 664, 608 in C_6H_6 ; 665, 609 in $CHCl_3$; 670, 614 in $C_6H_5NO_2$ (349).

$C_{18}H_{10}N_2O_6$.—Indigodicarboxylic acid: 648.7 in dil. NH_4OH ; 647.9 in dil. $NaOH$; 649.9 in dil. KOH (350).

$C_{18}H_{10}O_2S_2$.—Dye from oxythionaphthene and glyoxal: 509, 476 in xylene (167).

$C_{18}H_{11}NO_2$.—2-Naphthalene-2'-indoleindigo: 644, 591 in $CHCl_3$ (163); cf. (122).

$C_{18}H_{12}Br_2N_2O_2$.—6, 6'-Dibromo-1, 1'-dimethylindigo: 635 in xylene; 638 in tetralin (154); 638 in xylene (117).

$C_{18}H_{12}Cl_2N_2O_2$.—5, 5'-Dichloro-1, 1'-dimethylindigo: 665 in xylene (117).

$C_{18}H_{12}N_2O_2$.—Dye from indoxyl and glyoxal: 600, 555 in xylene (167).

$C_{18}H_{12}N_2O_2S$.—5-Isatinyl-3-p-tolylrhodanic acid: 433 in HOAc (677).

$C_{18}H_{12}O_4S_2$.—4, 4'-Dimethoxythioindigo: 554, 504 in $C_2H_2Cl_4$ (164).

5, 5'-Dimethoxythioindigo: 590 in $C_2H_2Cl_4$ (164).

6, 6'-Dimethoxythioindigo: 570, 530 in $C_2H_2Cl_4$ (164).

$C_{18}H_{14}N_2O_2$.—1, 1'-Dimethylindigo: 644.5 in xylene (117); 642 in xylene; 645 in tetralin (154); cf. (166).

7, 7'-Dimethylindigo: 603.8 in xylene; 617.7 in HOAc (187); 606.5 in tetralin (154); cf. (350, 524).

5, 5'-Dimethylisoindigo: 512 in H_2SO_4 (641).

7, 7'-Dimethylisoindigo: 528 in H_2SO_4 (641).

$C_{18}H_{14}N_2O_4$.—4, 4'-Dimethoxyindigo: 603 in $C_2H_2Cl_4$ (165).

5, 5'-Dimethoxyindigo: 644 in $C_2H_2Cl_4$ (165).

6, 6'-Dimethoxyindigo: 577 in $C_2H_2Cl_4$ (165).

7, 7'-Dimethoxyindigo: 644 in $C_2H_2Cl_4$ (165); 650.8 in $CHCl_3$ (350).

$C_{18}H_9BrO_2S$.—5-Bromo-2-thionaphthene-2'-acenaphthylenindigo: 520.5, 480.5 in xylene; 533.5, 483.5 in tetralin (154).

$C_{20}H_{10}O_2S$.—2-Thionaphthene-2'-acenaphthyleneindigo (C. I. 1228): 516.5, 479 in xylene; 519.5, 482 in tetralin (154). Ciba Scarlet G, 526, 490, 444 in C_9H_7N . Thioindigo Scarlet 2G, 525, 490 (116); cf. (190).

$C_{20}H_{12}O_2S_2$.—Dye from hydroxythionaphthene and maleic dialdehyde: 527, 484 in xylene (167).

$C_{20}H_{14}Br_2O_4S_2$.—5, 5'-Dibromo-6, 6'-diethoxythioindigo (C. I. 1218): 529, 490.5 in xylene; 531.5, 492.5 in tetralin (154); 539, 494 in C_9H_7N ; 598, 547, 501 in H_2SO_4 (116).

$C_{20}H_{14}Cl_2O_4S_2$.—4, 4'-Dimethyl-5, 5'-dichloro-7, 7'-dimethoxythioindigo (C. I. 1219): 590.5, 554 in xylene; 593.5, 556.5 in tetralin (154).

$C_{20}H_{14}N_2O_4$.—*N*, *N'*-Diacetylindigo: 545 in xylene (524); cf. (166).

$C_{20}H_{16}N_4O_4$.—5, 5'-Diacetyldiaminoindigo: (115).

$C_{20}H_{16}O_2S_2$.—4, 7, 4', 7'-Tetramethylthioindigo: 552, 511 in xylene; 555, 513 in tetralin (154).

$C_{20}H_{16}O_2S_4$.—6, 6'-Diethylthiothioindigo (C. I. 1216): 534.5, 494.5 in xylene; 537, 496.5 in tetralin (154). Helindone Scarlet S, 542, 492 in C_9H_7N ; 530, 490 in H_2SO_4 (116).

$C_{20}H_{16}O_3S$.—3, 4-Dihydro-2-naphthalene-6'-ethoxy-2'-thionaphtheneindigo: 565, 525 in $C_6H_5NO_2$ (168).

$C_{20}H_{16}O_4S_2$.—6, 6'-Diethoxythioindigo (C. I. 1217): 518.5, 485.5 in xylene; 520.5, 487.5 in tetralin (154). Helindone Orange R, 526, 490 in C_9H_7N ; 547 in H_2SO_4 (116).

$C_{20}H_{18}N_2O_2$.—*N*, *N'*-Diethylindigo: 650 in xylene; 653 in tetralin (524); 652.6 in $CHCl_3$ (350); cf. (266).

1, 5, 1', 5'-Tetramethylindigo: 655 in xylene (117).

$C_{21}H_{14}N_2O_4$.—Ethylindigomalonate: 550 in xylene. Benzoyl deriv., 505 in xylene (524).

$C_{22}H_{13}NO_2$.—1-Anthracene-2-indoleindigo: 660 in $C_2H_2Cl_4$ (43).

2-Anthracene-2-indoleindigo: 660, 603 in $C_2H_2Cl_4$ (43).

9-Anthracene-2-indoleindigo: 492 in $C_2H_2Cl_4$ (43).

$C_{22}H_{13}NO_2S$.—2-(*N*-Phenylindole)-2'-thionaphtheneindigo: 535 in H_2SO_4 (?) (166).

3-(*N*-Phenylindole)-2'-thionaphtheneindigo: 500 in H_2SO_4 (?) (166).

$C_{22}H_{13}NO_3$.—5-Hydroxy-2-anthracene-2-indoleindigo: 664, 606 in $C_2H_2Cl_4$ (43).

$C_{22}H_{14}N_2O_2$.—*N*-Phenylindirubin: 550 in H_2SO_4 (?) (166).

$C_{22}H_{16}O_4$.—*bis*-(4-Methoxynaphthalene)-indigo: 610 in C_6H_6 (185).

$C_{22}H_{18}N_2O_{10}$.—Tetramethoxyindigodicarboxylic acid: 563.3, 516.2 in H_2SO_4 (350).

$C_{24}H_{12}Br_2N_2O_2$.—Dibromo-*bis*- β -naphthindoleindigo (C. I. 1198): 619.5 in xylene; 623.5 in tetralin (154).

$C_{24}H_{12}O_2S_2$.—*bis*-1, 2-Naphthothiopheneindigo: 565 in $C_2H_2Cl_4$ (169).

bis-2, 1-Naphthothiopheneindigo: 577 in $C_2H_2Cl_4$ (169).

bis-2, 3-Naphthothiopheneindigo: 605 in $C_2H_2Cl_4$ (169).

bis-1, 8-Naphthothiopheneindigo: 644 in $C_2H_2Cl_4$ (169).

$C_{24}H_{13}NO_2S$.—Naphthindole-2, 1-naphthothiopheneindigo: 596 in $C_2H_2Cl_4$ (169).

$C_{24}H_{14}N_2O_2$.—*bis*-Naphthindoleindigo: 626 in $C_2H_2Cl_4$ (169). Ethylindigophenylacetate: 555 in xylene. Benzoyl deriv., 510 in xylene (524).

Dye from oxythionaphthene and terephthalic aldehyde: 488, 457 in C_7H_8 (167).

$C_{24}H_{16}N_2O_2$.—Dye from indoxyl and terephthalic aldehyde: 530, 490 in C_7H_8 (167).

$C_{24}H_{19}N_5O_2$.—Indigoazodimethylaniline: 572 (111).

$C_{26}H_{18}N_2O_3$.—Benzoyl-*o*-tolylindigo: 575 in xylene (524).

$C_{28}H_{18}N_2O_2$.—*N*, *N'*-Diphenylindigo: 630 in H_2SO_4 (?) (166).

$C_{29}H_{18}N_2O_4$.—Ethyl (anhydrophenylacetic acid)-indigomalonate: 555 in xylene (524).

$C_{30}H_{16}N_4O_8$.—*N*, *N'*-Dinitrobenzoylindigo: 570 in xylene (524). $C_{30}H_{18}N_2O_4$.—*N*, *N'*-Dibenzoylindigo: 578, 534 in xylene; 580, 536 in tetralin (154); 575 in xylene (524).

$C_{32}H_{18}N_2O_2$.—Lake Red Ciba B: 555 in xylene (524).

$C_{32}H_{18}N_4O_4Zn$.—"Zinc indigo": 570 in $CHCl_3$ (?) (353).

$C_{32}H_{26}N_6O_2S_2$.—*bis*-Dimethylanilinedisazothioindigo: 499 (111).

$C_{32}H_{28}N_8O_2$.—*bis*-Dimethylanilinedisazoindigo: 501 (111).

$C_{50}H_{52}N_6O_2$.—Di-(tetramethyldiaminodiphenylmethane)-diindoxyl: 596.4, 499.3 in H_2O after oxidation in HOAc soln. (540).

$C_{52}H_{56}N_6O_2$.—Di-(tetramethyldiaminodiphenylmethane)-di-*o*-methylindoxyl: 576.3, 507.4 in H_2O after oxidation in HOAc soln. (540).

Di-(tetramethyldiaminodiphenylmethane)-di-*p*-methylindoxyl: 634.3 in H_2O after oxidation in HOAc soln. (540).

The indigoid dye from α -aminopyridine and $ClCH_2CO_2H$ has a max. at 515 in slightly alk. soln. and "glyoxalin red" a max. at 510 (124). Dye max. in C_9H_7N :—Ciba Red R (C. I. 1229), 529, 491; Ciba Violet R (C. I. 1222, note), 603, 563; Helindone Brown 2R (C. I. 1223), 582, 530, 498; Helindone Brown 5R (C. I. 1224), 584, 532, 496; Helindone Violet B (C. I. 1219), 603 (?), 568; Helindone Violet 2B (C. I. 1219), 607, 562; Helindone Violet BD, 597, 549; Helindone Violet R (C. I. 1219), 574, 531 (116).

TABLE 12.—MISCELLANEOUS DYES

$C_6H_3N_3O_7$.—*sym*.-Trinitrophenol (picric acid, C. I. 7): 360 in EtOH; 380 with NaOEt; 380 in piperidine; 520 in benzene and anthracene (27); cf. (519, 332).

$C_{10}H_6N_2O_6$.—2, 4-Dinitro-1-naphthol, Na salt (Martius Yellow, C. I. 9): 445, 399, 379 in H_2O (370); cf. (3259, 3489).

$C_{10}H_6N_2O_8S$.—2, 4-Dinitro-1-naphthol-7-sulfonic acid, Na salt (Naphthol Yellow S, C. I. 10): 429, 399, 257 in H_2O (1799); cf. (3909, 3919, 4209, 4229).

$C_{10}H_6O_4$.—5, 6-Dihydroxy-1, 4-naphthoquinone (Naphthazarine): 488, 333, 267 in EtOH (394); neutral alkali salt, 627, 569, 309, in concd. H_2SO_4 , 548, 505, 325 (443); cf. (550); in acetic anhydride with boracetate, 580, 535 (268).

$C_{12}H_4N_7O_{12}NH_4$.—Hexanitrodiphenylamine, NH_4 salt (Aurantia, C. I. 12): 425 in H_2O (3909); cf. (391).

$C_{12}H_7Br_2NO$.—2, 6-Dibromo-*N*-(*p*-hydroxyphenyl)-*p*-quinoneimine: (1759).

$C_{12}H_7Cl_2NO$.—2, 6-Dichloro-*N*-(*p*-hydroxyphenyl)-*p*-quinoneimine: (1759).

$C_{12}H_8NO$.—Indophenol (*N*-(*p*-hydroxyphenyl)-*p*-quinoneimine): 630 in alk. H_2O ; 495 in acid H_2O ; 645 in alk. EtOH; 505 in acid EtOH (677).

$C_{12}H_{11}N_3$.—Indamine (*p*-aminophenyl-*p*-quinonediiimine) (Phenylene Blue): 660 (57); cf. (111); indamineazodimethylaniline, 598 (111).

$C_{13}H_9NO_2$.—2, 8-Dihydroxyacridine: 421 in H_2O (57).

$C_{13}H_{10}O_3$.—4, 4'-Dihydroxybenzophenone: 323 (550).

$C_{13}H_{10}O_5$.—3, 3', 4, 4'-Tetrahydroxybenzophenone: 449, 406 (550).

$C_{13}H_{11}N_3$.—2, 8-Diaminoacridine (Flavine): 427 in H_2O (57).

$C_{14}H_{14}N_2O$.—Phenol blue: (512).

$C_{16}H_{16}N_3(Cl)$.—2, 8-Diamino-3, 7-dimethylacridinium chloride (Acridine Yellow): 457 in H_2O ; 463.3 in EtOH; 464 in AmOH (155).

$C_{16}H_{19}N_4(Cl)$.—Toluylene blue: (512).

$C_{16}H_{11}NO_5S$.—*N*-(*p*-Hydroxyphenyl)-2-sulfo-1, 4-naphthoquinoneimine: 500 in neutral or acid H_2O ; 625 in alk. H_2O ; 510 in EtOH (272); cf. (269, 2829).

$C_{16}H_{12}Cl_2N_4O_7S_2$.—Xylene yellow, Na salt (C. I. 639): (6009).

$C_{16}H_{12}N_4O_9S_2$.—Tartrazine, Na salt (C. I. 640): 430, 260 (432); cf. (271, 3889, 4479, 6009).

$C_{16}H_{12}N_4O_9S_2$.—*m*-Sulfophenylhydrazone of 1-*m*-sulfophenyl-5-hydroxypyrazol-3-carboxylic acid, Na salt: 434 in H_2O (297).

$C_{16}H_{12}O_5$.—Succinylresorein: 504 in alk. H_2O (454).

$C_{16}H_{14}N_4O_4S$.—Flavazin L, Na salt (C. I. 636): (600).

$C_{16}H_{20}N_3(Cl)$.—Tetramethylindamine chloride (Bindschedler's Green): 730 in H_2O (465); perchlorate in acid EtOH, 640; polyacidic salts (306); 656.7 in $CHCl_3$; 669.6 in CS_2 ; influence of temp. (57); cf. (512).

$C_{17}H_{19}N_2S(Cl)$.—Thiopyronine: 564.5, 528 in H_2O ; 564.3, 524.2 in EtOH; 564.3, 524.2 in AmOH (155).

$C_{17}H_{20}N_2O$.—4, 4'-Tetramethyldiaminobenzophenone (Michler's Ketone): 368 in acid EtOH (644); cf. (192, 465); (see also 4, 101: 1469; 12.)

$C_{17}H_{20}N_3(Cl)$.—2, 8-Tetramethyldiaminoacridinium chloride (Acridine Orange, C. I. 788): 494.4, 463.9 in H_2O ; 490.9, 459.5 in EtOH; 490.9, 459.5 in AmOH (155).

$C_{17}H_{21}N_2(Cl)$.—4, 4'-Tetramethyldiaminobenzhydrol chloride (Michler's hydrol): 603.3 in H_2O ; 605 in EtOH (155); 610 in acid EtOH (644); cf. (111, 463, 465).

$C_{17}H_{22}N_3(Cl)$.—Auramine (C. I. 655): base, 300 in EtOH (192); ehloride in H_2O , 365, 315, 270 (420q); cf. (600q); 265 in H_2SO_4 (192); infra-red abs. (514); acetate in EtOH, 435, 375, (310) (192); cf. (38).

$C_{18}H_{10}N_2O_2$.—Triphenyldioxazine: 504, 470.5 in EtOH; 642.1, 586, 537.5 in H_2SO_4 (concd.) (155).

$C_{18}H_{12}N_4$.—Fluorindine: hydrochloride, 630.1, 578.7, 534.8, 497.3, 465.9 in EtOH (619.2, 570.2, 530.3 with HCl; 576, 532.8, 495.5 with NH_3) (155).

$C_{18}H_{16}N_2O$.—Indophenol P (C. I. 821): (516).

$C_{18}H_{19}N_2S(ClO_4)$.—*p*-Dimethylaminobenzylidene-*N*-methylbenzothiazole perchlorate: 528, 278 in EtOH; *o*-dimethylamino isomer, 478, 341 in EtOH (348).

$C_{19}H_{13}N$.—Phenylacridine: 348, 254 in EtOH (or $CHCl_3$); sulfate, 403, 348, 256 in EtOH (212).

$C_{19}H_{15}N_3$.—Chrysaniline: various salts (497); phosphine (C. I. 793), 481, 366, 280 in EtOH (421); 470 in H_2O (concd.); 472 (dil.) (269).

$C_{19}H_{21}N_4(Cl)$.—Cyanoacridine Orange (2, 8-dimethylamino-2, 5, 8, 10-tetrahydro-10-methyl-5-acridine nitrile): 585, 540, 280 in EtOH (221).

$C_{19}H_{24}N_3O(Cl)$.—Acetylauramine chloride: 350 in alk. H_2O (192); 385 in EtOH (582).

$C_{20}H_{10}(Fe)N_2O_{10}S_2(Na_2)$.—Naphthol Green (C. I. 5): 700 (510); infra-red abs. (511); cf. (510).

$C_{20}H_{12}OS_2$.—Dithiofluoran: 513, 363, 360 in HOAc + EtOH (442).

$C_{20}H_{13}NO_4$.—Resorcinolphthalamein: 489 in dil. NH_4OH (173).

$C_{20}H_{15}NO_3$.—Phenolphthalamein: 555 in dil. NH_4OH (173).

$C_{20}H_{16}N(Cl)$.—*N*-Methylphenylacridine ehloride: 436, 348, 265 in $CHCl_3$; 436, 348, 254 in EtOH; iodide in $CHCl_3$, 425, 354, 254 (212q); various acid salts (209).

$C_{20}H_{23}N_2O_3(Cl)$.—*asym.*-Dimethyl-*m*-aminophenolsuccinein (Rhodamine S, C. I. 743): 540 in H_2O and on wool (642).

$C_{20}H_{26}N_3O(I)$.—Acetylmethylauramine iodide: 600 in EtOH (582).

$C_{20}H_{27}N_3S$.—Tetraethylindamine sulfide: $ZnCl_2$ double salt, 656.5, 604.2 in EtOH (5).

$C_{20}H_{28}N_3(Cl)$.—Tetraethylindamine chloride: 659.4, 605.2 in EtOH; 657.3 in $CHCl_3$; 664.8 in CS_2 ; 673.9, 615.3 in H_2O (influence of temp.) (57).

$C_{21}H_{12}Br_4O_6$.—Tetrabromoresorcinolumbellein: 505 in H_2O + NH_3 (173).

$C_{21}H_{16}O_6$.—Resorcinolumbellein: 482 in H_2O + NH_3 (173).

$C_{21}H_{18}O_3$.—Phenolcinnamein: 565 in H_2O + NH_3 (173).

$C_{21}H_{18}O_5$.—Phenolumbellein: 543 in H_2O + NH_3 (173).

$C_{21}H_{20}N_3(Cl)$.—2, 8-Diamino-3, 7-dimethylphenylacridine ehloride (Benzoflavine, C. I. 791): 458 in H_2O ; 468 in EtOH; 468.8 in AmOH (155); cf. (465).

$C_{22}H_{22}O_7$.—Resorcinolcamphorein: 497.5 in alk. H_2O (594).

$C_{22}H_{24}O_4$.—Phenolcamphorein: 518 in alk. H_2O (594).

$C_{23}H_{23}N_2(OAc)$.—3, 6-Di-(dimethylamino)-9-phenyl-3-isofluorene: 621 (111).

$C_{23}H_{26}N_3O_2S(Cl)$.—Benzenesulfoneauramine chloride: 570 in EtOH (582).

$C_{24}H_{16}N_4O_9S_2$.—*p*-Sulfonaphthylhydrazone of 1-*p*-sulfonaphthyl-3-carboxy-5-pyrazolone: Na salt, 480 in H_2O (abs. of 5-sulfonaphthyl deriv. about the same) (297).

$C_{24}H_{23}N_3O_2$.—Tetramethylflaveosine: 500.7, 471.3 in H_2O ; 500.7, 471.3 in acid H_2O ; 493, 465.7 in EtOH; 494.8, 462.6 with acid (155).

$C_{24}H_{26}N_3O(Cl)$.—Benzoylauramine chloride: 590 in EtOH (582).

$C_{24}H_{28}N_4$.—Hexamethylrheonine: 503.2, 473.2 in H_2O ; 490.9, 458.2 in EtOH (155); 492.7, 460.2 in acid EtOH (193).

$C_{24}H_{28}O_4$.—*o*-Cresoleamphorein: 532 in alk. H_2O (594).

$C_{24}H_{28}N_4O_5S_2$.—Di-(methylisopropyl)-tartrazine: Na salt, 445 in H_2O (271).

$C_{25}H_{13}N_7O_{12}$.—1, 3, 6, 8-Tetranitrodinitrodiphenylcarbazine: 539 in alk. EtOH (304).

$C_{25}H_{15}N_6O_8$.—1, 3, 6, 8-Tetranitrodiphenylcarbazine: 542 in alk. EtOH (304).

$C_{25}H_{16}N_4O_6$.—1, 3, 6-Trinitrodiphenylcarbazine: 555 in alk. EtOH (304).

$C_{25}H_{17}N_3O_4$.—3, 6-Dinitrodiphenylcarbazine: 594 in alk. EtOH (304).

1 (?), 3-Dinitrodiphenylcarbazine: 572 in alk. EtOH (304).

$C_{25}H_{18}N_2O$.—2-Aminodiphenylcarbazone: 595 in EtOH; 591 in MeOH; 512 in Et_2O ; 508 in $CHCl_3$; 508 in CS_2 ; 500 in C_6H_6 ; 548 in Me_2CO ; 564 in C_6H_5N (305).

$C_{25}H_{18}N_2O_2$.—3-Nitrodiphenylcarbazine: 560 in alk. EtOH (304).

$C_{25}H_{19}N_3O$.—2, 4-Diaminodiphenylcarbazone: 535 in EtOH; 509 in Me_2CO ; 495 in Et_2O ; 490 in C_6H_6 (305).

$C_{28}H_{20}N_4O_6S_4$.—Chloramine yellow; C. I. 814 (Na salt): on wool (10).

$C_{28}H_{31}N_3O_2$.—Tetraethylflaveosine; 505.6, 473.6 in acid H_2O ; 492.6, 460.2 in EtOH (499.7, 467.5 with acid) (155).

$C_{30}H_{31}Br_4N_3O_2$.—Tetrabromotetraethylflaveosine, ethyl ester: 494.8, 466.3 in H_2O (495.5, 467 with acid); 498.2, 466.8 in EtOH (500, 468 with acid) (155).

$C_{30}H_{35}N_3O_2$.—Tetracthylflaveosine, ethyl ester: 507.7, 474 in H_2O (neutral or acid); 501.1, 467 in EtOH (501.9, 468 with acid) (155).

$C_{34}H_{40}N_4(OAc)_2$.—*bis*-Tetramethyldiaminodiphenylcarbinol diacetate: 599 (111).

Cyanile green: infra-red abs. (296).

Eastman Red Sensitizer No. 700: infra-red abs. (387).

Filter Yellow: ultra-violet abs. (447).

Immedial Black B: 610, 580 on cotton (522).

Immedial Pure Blue (C. I. 201): dyeings, (522, 627).

Immedial Purple: 545, 525 on linen (522).

Katigen Green 2S (C. I. 1006): 660, 540 on cotton (522).

Katigen Violet: 565, 540 on cotton (522).

Pontachrome Green GLO: 555 in H_2O (concd.), 575 (dil.) (269).

Aminopyrazolones: (123).

Azomethines: (30, 468, 469, 471, 475, 521, 542).

Citraconeins and itaconeins: (91).

Dianilides from substituted malachite green leuco bases and dinitrophenylpyridine ehloride (541).

Diphenylmethane derivatives: (192, 454, 463, 464, 467, 470, 529, 644).

Dirosanilides and rosdi-anilides of β -oxyacrolein and diformaldehydes (539).

Dyes from bromoeyanopyridine and secondary amines: (345).

Hydrazones: (29, 32, 53, 256, 360, 380, 434, 531, 597, 598, 618, 619).

Meriquinones: (77).

Nitro- and nitroso-compounds: (27, 51, 221, 222, 224, 333, 424, 447, 467, 468, 469, 470).

Pyronol dyes derived from natural coloring matters: (645).

Pyrrylmethane derivatives: (137, 141, 144, 145, 146, 229, 517, 651).

Substituted chromones: (249).

Succinyl- and glutaryl-fluoresceins and rhodamines: (112).

"Vinylene-homologous" indol and pyrrol dyes: (344).

TABLE 13.—NATURAL COLORING MATTERS

Aeaceticin: 333, 263; diacetyl deriv., 317 (606); cf. (608).

Aeaciin: 333, 263 (238); cf. (607).

Allochlorophyllan: 655, 600, 557, 533, 519, 487, 433, 413, (370) in Et₂O (405); cf. (2929, 2939, 2949, 412).

Alloporphyrin: 635, (600), 585, 573, 544, 507 in Et₂O; 623, (597), 578, 568, 534, 503 in alk. EtOH; chloride, 634, 576, 545, 507 in EtOH (610, (604), 575, 564, 556, 531 with excess HCl) (61); cf. (404).

Apigenidin: (16).

Apigenin: 333, 247 in EtOH (591); cf. (240, 5909, 607, 608); 341, 266 in dil. KOH; reduction product, 570 in dil. KOH (644). Trimethylapigenin (606).

Apiin: (240); cf. (607).

Aplysia punctata pigment: (499).

Bacteriochlorin: 593 in EtOH (68); cf. (478).

Bacterioerythrin: 548, 510, 470 in CS₂ (68).

Bacteriopurpurin: 593, 528, 490, 463 (mixture of bacteriochlorin and bacterioerythrin) (68); cf. (478).

Baiealein: 333, 271 in EtOH (5899). Triacetyl deriv., 288, 250 in EtOH (5899).

Baiealin: 286 in EtOH (5899). Tetraacetyl deriv., 300 in EtOH (5899).

Bilirubin: 638 with NH₃ and Zn salts (367); cf. (18, 37, 869, 2539, 515, 5859, 5869, 644, 6469). Copper bilirubin: 666.5 to 635.9 in EtOH with 1% HCl (354). Azo dye with diazoniumacetophenone salts: 522 in EtOH; 639 in KOH (496); cf. 202, 29: 411; 00).

Biliverdin: 639 in acid EtOH (367); cf. (515, 6469).

Bixin: (402).

Blood: (6019, 5999).

Bone marrow pigment (cattle): 488.8, 459.5, 433.4 in CHCl₃ (369).

Bromococcein: (106).

Bromoporphyrin I: 626.1, 570, 530.3, 495.8 in Et₂O (with HOAc); 598.6, 555.5 in 25% HCl (133).

Capsanthin: (673).

Carbon monoxide hemoglobin: 570, 538, 416, 347 (4809); cf. (99, 24, 78, 109, 2329, 233, 2369, 386, 548, 5999, 672); infra-red abs. (235); influence of temp. (234); action of light (237). [From human blood, 571.0; from *Arenicola*, 569.9 (36).]

Carbon monoxide sulfhemoglobin: (78, 386).

Carminic acid: 544, 504, 474 in H₂SO₄; 624, 581, 498, 466 in S. B. A.; 571, 530, 492 in alk. H₂O (101); cf. (102); influence of temp. (57); ammoniacal carmin, 560, 518 (369); carminic anhydride, 585, 545 in H₂SO₄; 580, 535 in S. B. A.; 580, 545 in dil. KOH (104).

Carotin: 485, 435 in EtOH; 517, 482 in CS₂ (662); 424 in Et₂O (93); 482, 451, 273 in cyclohexane (5309); cf. (5579, 5589, 617, 655). Hepatocarotin (95).

Chalkone: 302 in EtOH (also data on hydroxy- and alkyloxy-deriv.) (592).

Chetopterin: (547).

Chloroeruoirin: (157).

Chloroeruoroporphyrin: 641, 580, 553, 512 in Et₂O; 614, 559 in HCl (1:2) (158).

Chlorophyll: 670, (641), 614, 580, (540) in phytol (662); 656.5, 609.5, 537 in EtOH; 662, 607, 534.5 in Me₂CO (252); cf. (92, 286, 2919, 386, 404, 6479); infra-red abs., 745 (481); ultra-violet abs., 420.325 (374); colloidal solutions, 676, 616, 543.5 in EtOH + H₂O (252); cf. (662); living leaf, 678, (643), (616), (581), (543), 513 (662); 675.5, 615.5, 547 (252); cf. (2919, 404, 6269) [*Euglena* (19)]; "crystallized chlorophyll" (ethylechlorophyllide): 665, 615, (581), (538), (465), (433) in EtOH (652); cf. (404).

Chlorophyll A: 662, 612, 578, (531), (497), 459, 433 in Et₂O (662); 304 (92); colloidal soln., 678, 626, 588, (544), (500), 461 in H₂O with 1% Me₂CO (662). Hepatochlorophyll A (95).

Chlorophyll B: 663, 643, 613, 592, (565), (539), (503), 457, 429 in Et₂O (662); 304 (92). Hepatochlorophyll B: (95).

Chlorophyllan: (292, 293, 294, 398); (see Allo- and Neochlorophyllan).

Cholecyanin: 638 (367).

Chromodoris (zebra, etc.) pigment: 620-22 in formaldehyde; 622 in EtOH (83); 620 in alk. H₂O; 629 in acid H₂O (82).

Chrysin: (317), 266 in EtOH; diacetyl deriv., 286, 250 in EtOH (5919); cf. (240, 590, 607, 608). Dimethylchrysin: (606).

Coccinone: (100).

Copratin: 545, 516 with pyridine and hydrazine hydrate (568); cf. (573, 577).

Copratorporphyrin: 621.3, (574.5), 566.3, (529.3), 523.8, 493 in Et₂O with little HOAc; 591.5, 548.5 in 25% HCl; 592, 548.3 in H₂SO₄ (576); cf. (435, 571, 573, 577, 579). Methyl ester: 620.2, 565.3, 532.8, 498 in CHCl₃ (568). Fe complex: (574, 575, 576). Cu complex: (568, 579).

Coproporphyrin: 593.1, 573.5, 549.9, 524.5, 509.3 (also 405.4 according to 202, 126: 169; 23) in 25% HCl; 617.5, 565.5, 538.3, 503.3 in dil. KOH (565); 624, 597, 578, 568, 531, 497 in Et₂O (125); cf. (126, 329, 435, 483, 567, 571, 573, 577, 579, 6149). Methyl ester: 622.6, 597.6, (577.1, 567.6), 532.5, 498.9 in CHCl₃ (126); (also 405 (244)); cf. (125, 565, 568). Fe complex: (125, 574, 575, 577). Misc. derivs. (126, 579).

Corpus luteum pigment: (principally carotin) (369).

Crenilabrus blue (*Crenilabrus parvo*): (6749).

Cyanidin: 510.5, 269.5 in EtOH (5609); chloride, 545, (286) (608); (549 in EtOH (656)).

Cyanin chloride: 504 in 7% H₂SO₄; K salt (670), 598, 570 in salt soln. (656); cf. (608).

Cyanoheatin: (634).

Cyanoheochromogen: 568, 537 (634); cf. (570, 572).

Cyanoheoglobin: 551 (373); cf. (2419).

Cyanomethemoglobin: 539 (245).

Cyanomyochromogen: 555 (570, 572).

Cytochrome: 604.6, 566.5, 550.2, (532, 528), 521 (326); cf. (119, 327, 573, 670).

Delphinidin: 522.5, 275 in EtOH (5609); cf. (477, 660).

Delphinin chloride: 527 in 25% HCl (660).

Dermocybin: (337).

Deuterohemin: 545.6, 516.2 (135).

Deuteroporphyrin: 621.7, 595.7, 576.8, 566.8, 525.9, 494.1 in Et₂O; 592.4, (572.6), 549.3 in 25% HCl (135).

Diazona violacea pigments: green pigment, 620 in CS₂; violet pigment, 611 in ethyl benzoate, 606 in C₂H₂Cl₄ (284).

Dopamelanin: no characteristic bands in visible or ultra-violet (46).

Echinochrome (*Arbacia punctulata*): 530, 484 in Et₂O; 550, 530 in EtOH (530, 484 with HCl; 515, 484 with NH₃) (427).

Endothia pigments: (247q); endothine red (549q).
 Emodin: 680.7, 626.6 in H_2SO_4 (540.9, 500.4 on dilution) (350); cf. (337).
 Etiophyllin: (643), (621), (612), 578, 543, 498, (470, 458, 446) in Et_2O (662); cf. (139).
 Etioporphyrin: (646), 622, 611, 596, 576, 567, 528, 482 in Et_2O (662); Cu salt, 559.7, 522.7, 483.3 (180); halogen deriv. (148).
 Etiouroporphyrin: (and Fe salt) (130).
 Etioxanthoporphyrin: ultra-violet abs. (148).
 Eseulin: infra-red abs. (1.1), 3.9, 8.7 μ (296); ultra-violet abs., 340 (428); cf. (481).
 Flavone: 286, 250 in EtOH (591q); cf. (590q, 608); flavone coloring matters from various sources (591q); cf. (590q); flavone and flavonol derivs. (239).
 Fluorohemin: ethyl derivs. (356).
 Fluoromethemoglobin: 612, 494 (631); cf. (241q, 548).
 Fucoxanthin: 478, 448 in EtOH (662).
 Galangin: 366, 265 in EtOH (591q); cf. (590q, 608). Trimethylgalangin: (606).
 Glaucophyllin: (663), 601, 554, (521) in EtOH (662).
 Green animal coloring matters: (527).
 Green pigments of ripe seeds: (386).
 Helicorubin: (96).
 Hematerie acid (α -hematoporphyrin): 630.3, (604), 574.4, 540.6, 507 in CHCl_3 (566); 601, 555 in H_2SO_4 (571); cf. (435, 573, 579, 580); methyl ester (577); metallic complexes (574, 575, 577, 579).
 Hematin: 659, 578, 535 in dil. HCl; 616, 568, 540 in alk. H_2O ; 632 in EtOH; 630, 540, 502 in acid Me_2CO ; 580, 560, 524 in alk. Me_2CO (369); action of light (631): reduced hematin, 583.5, 556 (264); carbon monoxide reduced hematin, 566.5, 530 (264); cf. (70q, 368, 480q, 548, 633q); α -hematin: (566, 567, 568, 573, 577).
 Hematoporphyrin: 595.5, 573.8, 551.7, 526.3, 514.3, (507.8), 407.5 in 25% HCl (406.5, 390 in dil. acid); 618.5, 566.8, 540.5, 504.5, 461 in dil. KOH; 624, (597), 569, 529, 497, (471) in Et_2O (657); cf. (70q, 121, 186q, 230q, 244, 298, 368, 414, 435, 483q, 505, 548, 566, 567, 571, 573, 577, 599q, 611q, 661, 672, 676); acetyl deriv., 601, 554.5 in H_2SO_4 (578); esters (140, 244, 355, 564, 604q); metallic complexes (263, 453, 574, 575); α -hematoporphyrin: 629, 575, 540, 507 in CHCl_3 (566); cf. (505, 567, 580).
 Hemibilirubin: (371).
 Hemin: 612, 567, 390 in dil. alk. H_2O (369); 405 in CHCl_3 with NH_3 (414); cf. (125, 368, 403, 404, 672); hemin derivatives (184, 355, 356, 357, 358).
 Hemochromogen: 558, 526, 385 (369); cf. (70q, 94, 237, 263, 368, 548, 614q, 672); derivatives (263, 264, 327, 570).
 Hemoglobin: 558, 429 (369); infra-red abs. (235); ultra-violet abs. (538); action of light (237); Hb. of annelids (632q); ehloro-hemoglobins (639); cf. (9q, 15q, 24, 72q, 228q, 251, 263, 295, 328q, 368, 548, 672).
 Hemophyllin: (180).
 Hemoporphyrin: 592.8, 572.4, 549.7 in 25% HCl; 617.4, 570.5, 539.4, 505, 449 in dil. KOH (125); cf. (435, 504, 571); derivatives (139).
 Hepato-pancreas pigment of erayfish: secretion gave 560, (596) (372).
 Hesperetidin: (16, 17).
 Hesperetin: (17).
 Hydrobilirubin: 497 in acid H_2O ; 508 in EtOH with $\text{ZnCl}_2 + \text{NH}_3$ (371).
 Hypericum red (*Hypericum perforatum*): about 597, 547, 512 in 80% EtOH (75).
 Idaeine chloride: 507 in 7% H_2SO_4 (659).

Isoeoproporphyrin: 622.8, 597.1, 577.9, 568.2, 527.7, 494.4 in acetic ether; 591.2, 568.4, 547.1, 521.6, 505.9 in 5% HCl (126); β -isocoproporphyrin and various derivatives (126).
 Isomesoporphyrin: 622.5, 611.8, 596, 576.4, 567.1, 559.4, 544, 526.8, 494.1, 465 in Et_2O ; 589.5, 566.7, 546.9 in 5% HCl; ester and its Cu salt (147).
 Isoquercitrin: 362, 263 in EtOH (551).
 Isorhamnetin: 374, 255 in EtOH (591q); cf. (590q).
 Isouroporphyrin: 608.5, 558.2, 537.6, 502.9 in dil. NaOH; 598.2, 576.5, 552.2 in 25% HCl (128); octamethyl ester and Cu salt (128).
 Kämmerer's porphyrin: 603, 557, (554) in 25% HCl; 641, 582, 544, 509 in dil. KOH; 633, 578, 567, 533, 498 in Et_2O (125); cf. (132, 483q); dimethyl ester (132).
 Kämpferide: (590q, 591q, 608). Kämpferol and Kämpferitrin, (607, 608). Trimethylkämpferide (606).
 Kémeri's porphyrin: 638, 582, 534, 499 in Et_2O ; 595, 556 in 25% HCl (329).
 Kermesic acid: 633, 534, 501, 470 in H_2SO_4 ; 623, 576, 529, 493, 463 in S. B. A.; 567, 527, 493 in alk. H_2O (101); cf. (99); trimethyl ether, 500, 540 in H_2SO_4 (99); decarboxy deriv., 567, 527, 490 in alkali; 543, 504, 474 in H_2SO_4 (101); cf. (106).
 Lutein: (655); cf. (370, 373).
 Luteolin: 337, 253 in EtOH (591); cf. (590); reduction product (608).
 Lycopin: (654).
 Malvin: 519, 277.5 in slightly acid EtOH; 451, 389.5, 322 in slightly alk. EtOH (560q).
 Mandarin orange peel coloring matter: (330).
 Marennin (*Navicula ostrearia*): (47).
 Meconium pigment: 539, 576 in Me_2CO (band develops at 639 on long standing) (367).
 Melanins: (171).
 Mesobilirubin: Cu salt, 634.7, 580.3 in HOAc (142).
 Mesobilirubinogen: (483); condensation product with *p*-dimethylaminobenzaldehyde, 556 (483); condensation product with *p*-nitrobenzaldehyde, 545, 495 in EtOH (141).
 Mesobiliviolin: 606.5, 560.6, 498.3 in CHCl_3 ; Zn salt in EtOH, 626, 575, 509 (141).
 Mesobiliviolinogen: Zn salt, 556, 489 in EtOH (141).
 Mesoporphyrin: 592.7, 572.5, 549.7, 524, 509, 404.7 in 25% HCl; 629, 617, 601, (584, 574.5), (548, 526.5, 506.5) in dil. KOH (563); 623, 598, 579, 569, 528, 495 in Et_2O (125); cf. (139, 368, 369, 404, 435, 504, 505, 567, 571, 573, 577, 657, 672); dimethyl ester (139); metallic derivs. (574, 575, 671, 672).
 Methemoglobin: 631, 576, 540, 500 in neutral soln. (535); (410) (369); (604), 577.9, 540.6 in alk. soln. (233); (493, 415) (369); action of light (237); Met. Hb. of annelids (632); cf. (25, 70q, 73, 109, 227, 241q, 242q, 255, 366q, 368, 435, 548).
 Methyl ehlorophyllide a: 662, 612, 578, 532, (500), 458, 432, in Et_2O (662); 641, 596, (566), 526, 494, 458 in alk. EtOH (663).
 Methyl ehlorophyllide b: 663, 643, (614), 593, (566), 539, (504), 456, 430 in Et_2O (662); 641, 625, 580, (537) in alk. EtOH (663).
 Methyl phäophorbide a: 666, (635), 608, (559), 533, 502, (471) in Et_2O (663).
 Methyl phäophorbide b: 656, 599, 558, 534, 520, (489), (448), 436 in EtOH (663).
 Morin: (644); pentamethylmorin (606); morin reduction product, 586 in dil. KOH (644); cf. (608).
 Musele pigment: (200).
 Mycoporphyrin (*Penicillium clavariaciformis*): (91).
 Myochromogen: 549.5, 519 (569, 572).
 Myohematin: (569, 572). (Cytochrome.)
 Myricetin: 374, 253 in EtOH (591); cf. (590q, 607); hexamethyl-deriv. (606); myricitrin (607); reduction product of myricetin and myricitrin (608).

Myrtillidine chloride: 583 in EtOH (665).
 Myrtilline chloride: 517 in 7% H₂SO₄ (665).
 Naringenin: (592q, 593).
 Naringin: (592q, 593).
 Neochlorophyllan: 667, 606, (559), 532, 496, (471), 411, 393, 371 in Et₂O (405); 668, 607, (563), 537, 506, 414, 399, 374 in CHCl₃ (294q); cf. (292q).
 Nephroresin: (14).
 Nitric oxide hemoglobin: 578.5, 541.8 (233); cf. (241q, 242, 548).
 Nitrite methemoglobin: (631.1), 577, 539 (233); cf. (241q).
 Oerein: (416).
 Oenidine chloride: 553 in EtOH (665).
 Oenine chloride: 518 in 7% H₂SO₄ (665).
 Ooporphyrin: (132, 134, 566); dimethylester (125); esters and Fe complexes (132).
 Oxyhellicorubin: (96).
 Oxyhemoeyanin: 571 to 581 in alk. H₂O with samples of different origins; ultra-violet bands at 346, 278 (69); 579, 475 (mollusks); 563, 475 (arthropods) (536).
 Oxyhemoglobin: infra-red abs. (235); 577.5, 541.7, 411.5 (562); ultra-violet abs. (251, 417, 480, 507); effect of light (237); influence of temp. (234, 289); action of Cl, etc. (425); effect of phenylhydrazine (373); cf. (9q, 71q, 72q, 73q, 89q, 109, 226q, 228, 232q, 233, 236q, 241q, 255q, 368, 369, 414, 548, 599q, 672); of human blood, 576.4; of *Arenicola*, 574.6; of *Nepheys*, 575.7 (36); of annelids (632).
 Paeonidin: 511, 274 in EtOH (560q).
 Papendieck porphyrin (chloroform-soluble): 630, 576, 540.5, 507 in CHCl₃; 632, (585, 575.5), 535, 501 in Et₂O; 603.5, 557.5 in 25% HCl (565); cf. (132, 503); ester (132).
 Parahematin: (327).
 Pelargonidine: 504.5, 450, 400.5, 331, 267 in EtOH (560); chloride (608, 653, 664).
 Pelargonine chloride: (608, 653).
 Phäophytin: 662, 607, 561, 533, 501 in Me₂CO; Cu compd., 633, 599, 561 in Me₂CO; Zn compd., 654, 605.5, 564.5, 524 in Me₂CO; (data on colloidal solns.) (252).
 Phäophytin component a: 667, (635), 608, (559), 533, 502, 471 in Et₂O (663).
 Phäophytin component b: 656, 600, 559, 534, 520, (503), 449, 434 in EtOH (663).
 Phonoporphyrin: 593, 573, 549 in 25% HCl; 621, 572, 540, 506 in dil. KOH (125).
 Phycoeyan: blue violet pigment (*Ceramium rubrum*), 616, 551 in H₂O; blue pigment (*Phormidium* sp.), 613, 575 in H₂O; blue green pigment (*Gallaei siridot*), 621 in H₂O (359); cf. (331, 365q); *Pal-mellococcus* (49); *Schizophyces* (48).
 Phycoerythrin: (*Ceramium rubrum*), 567, 539, 495 in H₂O (359); (*Nostoc commune*) (610); (*Phormidium persicinum*) (650); cf. (331) (data on ultra-violet abs.) (365q, 545).
 Phylloerythrin: (641), 594, 567, 526 in CHCl₃; 620, 611, 570, (536) in HOAc + HCl (613, 567, 525 with zinc acetate) (407); cf. (131, 414q).
 Phyllohemine: (403); β-phyllohemine, 606.5, 556.5 in H₂SO₄; 556, 549.5, (522) with pyridine and hydrazine hydrate (571).
 Phyllophyllin: 594, 583, 551, 510, (480) in Et₂O (662).
 Phylloporphyrin: 632, 622, (604), 576, 567, 533, 501 in Et₂O; 628, 574, 537, 503 in alk. EtOH; chloride (609), 567, 536, (502) in EtOH (604, 561, (520) with excess HCl) (658); cf. (125, 404q, 563); phylloporphyrin β: 604.5, 556 in H₂SO₄ (571); cf. (573).
 Phytochlorin e: lactam hydrate, 667, 609, (558), 531, 500 in Et₂O (662); 664, 613, 584, 533, (497) in 3% HCl; 662, 634, 606, 558, 534, 501, 467 in MeOH with 5% KOH (663).
 Phytorhodin g: 654, 599, 562, 527 in Et₂O (662); 647, 589, 563, 538 in 9% HCl; 653, 599, 575, (556), 531 in MeOH with 5% KOH (663).
 "Porphyrin X:" (435).

Protopelargonidine: 438, 481 in pH 5 to 6 soln., 538 in alk. soln., (477).
 Protoporphyrin: 604, 581.4, 558.2 in 25% HCl (abs. of dimethyl ester and metallic complexes also given) (143).
 Pyocyanus pigments: ultra-violet abs. (551).
 Pyrrole black: (171).
 Pyrrophyllin: (620), 582, 542, 503 in EtOH (662).
 Pyrroporphyrin: (650), 622, 597, 568, 525, (498, 492, 487) in Et₂O; 621, (596), (575, 567), 529, 497 in alk. EtOH; chloride (620), 599, 568, 560, 552, 529, 496 in EtOH (600, (569, 560, 552), 527 with excess HCl) (658); cf. (125).
 Quercetin: 375, 258 in EtOH (551); cf. (590q, 591q, 607, 608, 644); quereitrin, (607, 608); quereimeritrin (550); reduction products (608, 644); pentamethylquercetin (606); pentaacetylquercetin (591).
 Resoapigenidin: 465; 489 in pH 5 to 6 soln.; 540 in alk. soln. (477).
 Resoehrysinidin: 435; 487 in pH 5 to 6 soln. (477).
 Rhizostoma curvieri pigment (zoocyanin): 640, 590, 560 (675).
 Rhodochlorogen (Hawaiian *Dioscorea*): 520 in acetie ether (38).
 Rhodophyllin: 599, 554, (516) in EtOH (662); 584, 545, (505) in alk. EtOH (661).
 Rhodoxanthin: (479).
 Rutin: 363, 263 in EtOH (552); reduction product (608).
 Sakuranetinidin: (16).
 Sapporoporphyrin D: 624.2, 568.8, 527, 496 in Et₂O; 597.5, 552 in H₂SO₄ (578).
 Schizoneura lanigera pigment: 651, 589, 571, 543, 526, 504, 478 in Et₂O (561).
 Schizophyceae phycoerythrin: (48, 49).
 Scutellarein (and scutellarin): (240, 589q).
 Selenohemoglobin: (78).
 Shikizarin: 480, 333, 281, 250 in EtOH (394).
 Shikonin: 513, 282 in EtOH (394).
 Skatol red: (285).
 Stercobilin: (34).
 Stick lac: (615); cf. (102).
 Sulfhematin: (634).
 Sulfhemoglobin: 623, (579, 542), 423 in H₂O (369); cf. (386, 548).
 Syringidin: 520, 273.5 in EtOH (560).
 Thujorhodin: (616).
 Turacin: 565, 528 in H₂O with NH₃ (129); cf. (327).
 Urinary pigments: pathological pigment (364); pigment isolated with *p*-dimethylaminobenzaldehyde (attributed to skatoxyl) (553).
 Urobilin: 495 in EtOH; 510 in EtOH with ZnCl₂; 511 in alk. H₂O; 496 in acid H₂O (371); cf. (198, 373, 672); urobilinogen: (483q).
 Uroerythrin: (50).
 Uroporphyrin: 596.7, 577, 553.4, 526.3, 511.8 in 25% HCl; 611.3, 559.3, 538.4, 501.8 in dil. KOH (565); 600, 555.5 in H₂SO₄ (571); cf. (125, 435, 577); methyl ester, 625, 599, (581.5, 570.5), 536, 499.5 in CHCl₃ (565); 408 (244); cf. (125, 577); metallic salts (125, 126, 575).
 Urorosein: (14, 285).
 Vegetable oils: cottonseed (526q); cf. (415); sesame (415); cf. (52); soya bean (526); misc. (415).
 Visual purple: 503 in H₂O; 511 in the rods; 540 (corr.) in the cones (248); 565, 530, 500 (630).
 Wogonin: 286 in EtOH; acetyl wogonin, 290, 248 in EtOH (589q).
 Worm porphyrin: 607, 571, 544 in HOAc; 629, 579, 539, 504 in Et₂O (125).
 Xanthophyll: 475, 445, 419 in Et₂O (93); 478, 448 in EtOH; 508, 476 in CS₂ (662); cf. (558q, 655); hepatoxanthophyll (95).
 Zooerythrin: (537).

The greater part of the tabulated data on chlorophyll derivatives was taken from the work of Willstätter and his collaborators. The following references to the work of Marchlewski and his collaborators may also prove of interest: (397, 400, 401, 404, 406, 410, 411, 414).

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Adams and Haller, 1, 42: 2661; 20. (2) Adams and Rosenstein, 1, 36: 1452; 14. (3) Adinolfi, 22, 31: 461; 22. (4) Adinolfi, 71, 32: 189; 26. (5) Althausse and Krüss, 25, 22: 2065; 89. (6) Ambler and Holmes, 166, 60: 501; 24. (7) Anderson, 1, 50: 208; 28. (8) Anderson and Gombert, 1, 50: 203; 28. (9) Anson, Barcroft, Mirsky and Oinuma, 5B, 97: 61; 24.
- (10) Appel, 483, 17: 49; 28. (11) Appel and Brode, 45, 16: 797; 24. (12) Appel, Brode and Welch, 45, 18: 627; 26. (13) Arnold, E. L., 1, 46: 489; 24. (14) Arnold, V., 202, 71: 1; 11. (15) Arons and Müller, 203, Suppl. 1: 109; 06. (16) Asahing and Inubuse, 25, 61: 1646; 28. (17) Asahing, Shinoda and Inubuse, J. Pharm. Soc., Japan, 48: 207; 28. (18) Auché, 34, 146: 496; 08. (19) Baas-Becking and Ross, 223, 9: 111; 25.
- (20) Baker, 4, 91: 1490; 07. (21) Baker, T. T., and Davidson, 204, 62: 375; 23. (22) Baker, T. T., Davidson and Balmain, 290, 41: 267; 25. (23) Balls, Hewitt and Newman, 4, 101: 1840; 15. (24) Balthazard, 561, 6: 618; 24. (25) Balthazard and Philippe, Ann. méd. légale, 6: 137; 26. (26) Baly and Hampson, 4, 107: 248; 15. (27) Baly and Rice, 4, 103: 2085; 13. (28) Baly and Tryhorn, 4, 107: 1121; 15. (29) Baly and Tuck, 4, 89: 982; 06.
- (30) Baly, Tuck and Marsden, 4, 97: 571; 10. (31) Baly, Tuck and Marsden, 4, 97: 1494; 10. (32) Baly, Tuck, Marsden and Gazdar, 4, 91: 1572; 07. (33) Barabasz and Marchlewski, 205, 21: 548; 09. (34) Barbier and Sisley, 6, 13: 96; 08. (35) Barcroft and Barcroft, 5B, 96: 28; 24. (36a) Bareggi, Folia clinica, 1: 194; 26. (37) Barrenghe and Weltman, 205, 140: 273; 23. (38) Bartlett, U. S. Bur. Plant Ind., Bull. 264: 13. (39) Battagay and Amuat, 27, 35: 1450; 24.
- (40) Battagay and Bernhardt, 27, 33: 1510; 23. (41) Bentley, Friedl, Thomas and Weizmann, 4, 91: 411; 07. (42) Bernthsen, 13, 229: 73; 85. (43) Bezdik and Friedländer, 57, 30: 871; 09. (44) Biehringer, 13, 391: 308; 12. (45) Birge and Acree, 1, 41: 1031; 19. (46) Block and Schaaf, 205, 162: 181; 25. (47) Bocat, 206, 62: 1073; 07. (48) Boresch, 205, 119: 167; 21. (49) Boresch, Ber. botan. Ges., 40: 288; 22.
- (50) Borries, 49, 16: 45; 17. (51) Bortini, 7, 87: 104; 14. (52) Bosch, 233, 50: 526; 13. (53) Brady and McHugh, 4, 121: 1648; 22. (54) Brand, Stallmann, Groebe and Stein, 52, 109: 1; 25. (55) Braunholtz, 4, 121: 169; 22. (56) Braunholtz and Mills, 4, 121: 2004; 22. (57) Bremer, 93, 1: 112; 92. (58) Brode, 1, 46: 581; 24. (59) Brode, 1, 48: 1984; 26.
- (60) Brode, 45, 18: 708; 26. (61) Brode, 50, 30: 56; 26. (62) Brode, 25, 61: 1722; 28. (63) Brode and Adams, 1, 46: 2032; 24. (64) Brode and Adams, 1, 48: 2193; 26. (65) Brown and Cummings, 54, 45: 355; 26. (66) Buch, 138, 2: Nos. 19-30; 26. (67) Buck and Heilbron, 4, 121: 1198; 22. (68) Buder, Jahrb. wiss. Botanik, 58: 525; 19. (69) Burdel, Thesis, Fribourg, 1922.
- (70) Bürker, in Tigerstedt, Handbuch der physiologischen Methodik; 1911. (71) Butterfield, 202, 62: 173; 09. (72) Butterfield, 202, 79: 439; 12. (73) Butterfield and Peabody, J. Expt. Med., 17: 587; 13. (74) Camichel and Bayrac, 34, 132: 882; 01. (75) Cerný, 202, 73: 731; 11. (76) Ciusa, 36, 51: 49; 21. (77) Clark, Cohen and Gibbs, 231, Suppl. No. 54; 26. (78) Clarke and Hurlley, 289, 36: 62; 07. (79) Cluzet, Roehaix and Kofman, J. physiol. path. gén., 17: 378; 21.
- (80) Coblenz, 2, 16: 119; 03. (81) Cohen, 231, 41: 3051; 26. (82) Crozier, 289, 47: 491; 14. (83) Crozier, 223, 4: 303; 22. (84) Crymble, Stewart and Wright, 25, 43: 1188; 10. (85) Cumming and Ferrier, 4, 125: 1108; 24. (86) Cutten, Emerson and Woodruff, 562, 41: 428; 28. (87) Danaila, 34, 149: 1383; 09. (88) Danaila, 27, 7: 359; 10. (89) Davis, 453, 34: 279; 27.
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- (100) Dimroth, 13, 399: 1; 13. (101) Dimroth and Fick, 13, 411: 315; 16. (102) Dimroth and Goldschmidt, 13, 399: 62; 13. (103) Dimroth and Hilken, 25, 54: 3050; 21. (104) Dimroth and Kämmerer, 25, 53: 471; 20. (105) Dimroth and Ruck, 13, 446: 123; 25. (106) Dimroth and Scheurer, 13, 399: 43; 13. (107) Dimroth, Schultze and Heinze, 25, 54: 3035; 21. (108) Dornier and Martinet, 27, 33: 779; 23. (109) Doumer and Fourrier, 206, 93: 1364; 25.
- (110) Ducou, Ann. méd. légale, 6: 84; 26. (111) Dutt, 4, 1926: 1171. (112) Dutt and Thorpe, 4, 125: 2524; 24. (113) Eckert and Tomaschek, 75, 127: 649; 18. (114) Eder, 57, 6: 927; 85. (115) Eder, 57, 24: 13; 03. (116) Eijman, 176, 8: 333; 11. (117) Ettinger and Friedländer, 25, 45: 2074; 12. (118) Ettinger and Friedländer, 25, 45: 2081; 12. (119) Euler and Fink, 202, 164: 69; 27.
- (120) Everest and McCombie, 4, 99: 1752; 11. (121) Fabre, 34, 181: 623; 25. (122) Felix and Friedländer, 57, 31: 55; 10. (123) Fierz-David, Künstliche organische Farbstoffe. Berlin, 1926. (124) Finger and Kraft, 25, 57: 1950; 24. (125) Fischer, H., in Oppenheimer, Handbuch der Biochemie. Jena, 1923. (126) Fischer, H., and Andersag, 13, 458: 117; 27. (127) Fischer, H., and Beller, 13, 444: 238; 25. (128) Fischer, H., and Heisel, 13, 457: 83; 27. (129) Fischer, H., and Hilger, 202, 138: 49; 24.
- (130) Fischer, H., and Hilger, 202, 140: 223; 24. (131) Fischer, H., and Hilmer, 202, 143: 1; 25. (132) Fischer, H., and Kögl, 202, 138: 262; 24. (133) Fischer, H., and Kotter, 25, 60: 1861; 27. (134) Fischer, H., and Lindner, 202, 142: 141; 25. (135) Fischer, H., and Lindner, 202, 161: 17; 26. (136) Fischer, H., and Meyer, 202, 75: 339; 11. (137) Fischer, H., and Meyer-Betz, 202, 75: 232; 11. (138) Fischer, H., and Meyer-Betz, 57, 59: 799; 12. (139) Fischer, H., and Müller, 202, 142: 120; 25.
- (140) Fischer, H., and Müller, 202, 142: 155; 25. (141) Fischer, H., and Niemann, 202, 137: 293; 24. (142) Fischer, H., and Niemann, 202, 146: 196; 25. (143) Fischer, H., and Pützer, 202, 154: 39; 26. (144) Fischer, H., and Schubert, 25, 56: 1202; 23. (145) Fischer, H., and Schubert, 25, 56: 2379; 23. (146) Fischer, H., and Schubert, 25, 57: 610; 24. (147) Fischer, H., and Treibs, 13, 450: 132; 26. (148) Fischer, H., and Treibs, 13, 457: 209; 27. (149) Fischer, O., 52, 98: 204; 18.
- (150) Fischer, O., and Scheibe, 52, 100: 86; 20. (151) Formánek, 563, 2: 171; 03. (152) Formánek, 563, 2: 473; 03. (153) Formánek, 563, 4: 33; 05. (154) Formánek, Chem. obzor, 3: 133; 28. (155) Formánek and Grandmougin, Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege, Part I, Berlin, 1908. (156) Formánek and Knop, 91, 56: 273; 17. (157) Fox, H., 5B, 99: 199; 26. (158) Fox, H., 58, 117: 49; 26. (159) Fox, J., 4, 97: 1337; 10.
- (160) Fox, J., 4, 101: 1498; 12. (161) French, 45, 18: 298; 26. (162) French, 559, 2: 124; 27. (163) Friedländer, 25, 41: 772; 08. (164) Friedländer, 25, 49: 955; 16. (165) Friedländer, Bruckner and Deutsch, 13, 388: 23; 12. (166) Friedländer and Kunz, 25, 55: 1597; 22. (167) Friedländer and Risse, 25, 47: 1919; 14. (168) Friedländer and Sander, 25, 57: 637; 24. (169) Friedländer and Woroschov, 13, 388: 1; 12.
- (170) Gaidukov, Z. Farben-Ind., 7: 267; 08. (171) Gallerani, Arch. ital. biol., 72: 189; 24. (172) Gattermann, 25, 32: 1127; 99. (173) George, 557, 13: 259; 26. (174) Ghosh and Watson, 4, 111: 815; 17. (175) Gibbs, H., 141, 72: 649; 27. (176) Gibbs, R., Howe and Tyndall, 2, 10: 779; 17. (177) Gibbs, R. and Shapiro, 1, 50: 1755; 28. (178) Gibbs, R. and Shapiro, 1, 50: 2798; 28. (179) Gibson, McNicholas, Tyndall, Frehafer and Mathewson, 31, 440: 22.
- (180) Gnehm, 52, 76: 401; 07. (181) Gnehm, 52, 76: 471; 07. (182) Gnehm and Käufer, 25, 37: 3032; 04. (183) Gnehm and Rübel, 52, 64: 497; 01. (184) Goldman, 205, 172: 127; 26. (185) Gorke, Köpper and Staiger, 25, 41: 1156; 08. (186) Goto, 205, 135: 329; 23. (187) Grandmougin, 25, 42: 4218; 09. (188) Grandmougin, 25, 42: 4408; 09. (189) Grandmougin, 25, 43: 937; 10.
- (190) Grandmougin, 136, 34: 1076; 10. (191) Grandmougin, 34, 173: 1363; 21. (192) Grandmougin and Favre-Ambrumyan, 25, 47: 2127; 14. (193) Grandmougin and Lang, 25, 42: 3631; 09. (194) Grandmougin and Seydier, 25, 47: 2365; 14. (195) Graves and Adams, 1, 45: 2439; 23. (196) Grebe, 7, 10: 673; 92. (197) Gsell, 91, 55: 417; 16. (198) Guigues, 345, 16: 86; 09. (199) Gulik, 8, 46: 147; 15.
- (200) Günther, Arch. path. Anat. (Virchow's), 230: 146; 21. (201) Ilalban and Siedentopf, 7, 100: 208; 22. (202) Hamer, 4, 119: 1432; 21. (203) Hamer, 4, 123: 246; 23. (204) Hamer, 4, 123: 2333; 23. (205) Ilamer, 4, 125, 1348; 25. (206) Ilamer, 4, 1927: 2796. (207) Ilamer, 4, 1928: 206. (208) Hantzsch, 25, 41: 1187; 08. (209) Hantzsch, 25, 42: 68; 09.
- (210) Hantzsch, 25, 42: 2129; 09. (211) Hantzsch, 25, 43: 2512; 10. (212) Hantzsch, 25, 44: 1783; 11. (213) Hantzsch, 9, 18: 470; 12. (214) Hantzsch, 25, 46: 1537; 13. (215) Hantzsch, 25, 48: 158; 15. (216) Hantzsch, 25, 48: 167; 15. (217) Hantzsch, 25, 49: 511; 16. (218) Hantzsch, 25, 52: 509; 19. (219) Hantzsch, 25, 54: 2573; 21.
- (220) Hantzsch and Glover, 25, 39: 4153; 06. (221) Hantzsch and Hein, 25, 52: 493; 19. (222) Hantzsch and Koczynski, 25, 42: 1217; 09. (223) Hantzsch and Lifschitz, 25, 45: 3011; 12. (224) Hantzsch and Lister, 25, 43: 1685; 10. (225) Hantzsch and Robertson, 25, 43: 106; 10. (226) Hari, 205, 82: 229; 17. (227) Hari, 205, 103: 271; 20. (228) Hari, 205, 115: 52; 21. (229) Hari, 205, 117: 41; 21.
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- (260) Hewitt and Thole, *4*, 97: 511; 10. (261) Hewitt and Thomas, *4*, 95: 1292; 09. (262) Hildebrand, *9*, 14: 349; 08. (263) Hill, *230*, 19: 341; 25. (264) Hill, *5B*, 100: 419; 26. (265) Holmes, *560*, 13: 6; 23. (266) Holmes, *560*, 13: 54; 23. (267) Holmes, *45*, 15: 833; 23. (268) Holmes, *1*, 46: 208; 24. (269) Holmes, *45*, 16: 35; 24.
- (270) Holmes, *1*, 46: 627; 24. (271) Holmes, *1*, 46: 631; 24. (272) Holmes, *1*, 46: 2770; 24. (273) Holmes, *45*, 17: 59; 25. (274) Holmes, *45*, 17: 918; 25. (275) Holmes, *1*, 49: 790; 27. (276) Holmes, *483*, 16: 429; 27. (277) Holmes, *559*, 3: 45; 28. (278) Holmes and Hann, *559*, 3: 122; 28. (279) Holmes and Scanlan, *1*, 49: 1594; 27.
- (280) Holmes and Snyder, *1*, 47: 221; 25. (281) Holmes and Snyder, *1*, 47: 226; 25. (282) Holmes and Snyder, *1*, 47: 2232; 25. (283) Holmes and Snyder, *1*, 50: 1907; 28. (284) Holt, *5B*, 88: 227; 14. (285) Homer, *141*, 22: 345; 12. (286) Houstoun, *8*, 21: 535; 06. (287) Howe, *2*, 8: 674; 16. (288) Howe and Gibson, *2*, 10: 767; 17. (289) Hüfner, *202*, 58: 39; 08.
- (290) Hüttig, *7*, 87: 129; 14. (291) Iwanowski, *Ber. botan. Ges.*, *25*: 416; 07. (292) Jacobson, *1*, 34: 1266; 12. (293) Jacobson and Marchlewski, *205*, 39: 174; 12. *1*, 47: 221; 25. (294) Jacobson and Marchlewski, *205*, 40: 296; 12. (295) Jirgensons, *205*, 194: 140; 28. (296) Johnson, J. and Spence, *2*, 5: 349; 15. (297) Johnson, M., *54*, 40: 176; 21. (298) Kajdi, *205*, 165: 475; 25. (299) Kalandek, *63*, 9: 128; 08.
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- (310) Kehrman and Hempel, *25*, 50: 856; 17. (311) Kehrman, Robert and Sandoz, *25*, 49: 2831; 16. (312) Kehrman and Sandoz, *25*, 50: 1667; 17. (313) Kehrman and Sandoz, *25*, 50: 1673; 17. (314) Kehrman and Sandoz, *25*, 51: 915; 18. (315) Kehrman and Sandoz, *25*, 51: 923; 18. (316) Kehrman and Sandoz, *37*, 1: 270; 18. (317) Kehrman and Sandoz, *37*, 3: 104; 19. (318) Kehrman and Sandoz, *25*, 53: 63; 20. (319) Kehrman and Sandoz, *37*, 4: 31; 21.
- (320) Kehrman and Sandoz, *37*, 5: 895; 22. (321) Kehrman and Sandoz, *37*, 6: 982; 23. (322) Kehrman and Sandoz, *37*, 8: 250; 25. (323) Kehrman, Speitel and Grandmougin, *25*, 47: 2976; 14. (324) Kehrman, Speitel and Grandmougin, *25*, 47: 3205; 14. (325) Kehrman, Speitel and Grandmougin, *25*, 47: 3363; 14. (326) Keilin, *5B*, 98: 312; 25. (327) Keilin, *5B*, 100: 129; 26. (328) Kennedy, *131*, 79: 346; 27. (329) Kémeri, *205*, 151: 438; 25.
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- (360) Lankshear and Lapworth, *4*, 99: 1785; 11. (361) Lasareff, *8*, 24: 661; 07. (362) Lasareff, *8*, 37: 812; 12. (363) Lasareff, *7*, 100: 266; 22. (364) Lehmann and Zinn, *Berl. klin. Wochschr.*, *47*: 2244; 10. (365) Lemberg, *13*, 461: 46; 28. (366) Letsche, *202*, 80: 412; 12. (367) Lewin, *278*, 145: 393; 12. (368) Lewin, Miethe and Stenger, *34*, 143: 115; 06. (369) Lewin, Miethe and Stenger, *278*, 118: 80; 07.
- (370) Lewin, Miethe and Stenger, *278*, 124: 585; 08. (371) Lewin and Stenger, *278*, 144: 279; 12. (372) Lewin and Stenger, *278*, 178: 80; 20. (373) Lewin and Stenger, *99*, 21: 221; 22. (374) Lewkowsitch, *230*, 22: 777; 28. (375) Ley, *25*, 50: 243; 17. (376) Ley, *7*, 94: 405; 20. (377) Ley and Engelhardt, *25*, 41: 2509; 08. (378) Leyko and Marchlewski, *205*, 22: 464; 09. (379) Liebermann, *25*, 21: 2527; 88.
- (380) Lifschitz, *25*, 47: 1401; 14. (381) Lifschitz, *25*, 52: 1919; 19. (382) Lifschitz and Laurié, *25*, 50: 897; 17. (383) Lipmaa, *34*, 182: 867; 26. (384) List, *202*, 138: 164; 24. (385) Llemura and Tabei, *41B*, 3: 105; 28. (386) Long and Spriggs, *Quart. J. Med.*, *11*: 102; 18. (387) Lubimenko, *34*, 142: 1432; 06. (388) Lubovitch and Peaven, *69*, 16: 195; 22. (389) Lund, *1*, 49: 1346; 27.
- (390) Lunelund, *60*, 59A: No. 21; 16. (391) Lunelund, *60*, 60A: No. 12; 17. (392) Lunelund, *60*, 62A: No. 5; 19. (393) Macbeth and Maxwell, *4*, 123: 370; 23. (394) Majima and Kuroda, *558*, 1: 43; 22. (395) Maki, *43*, 11: 1; 20. (396) Maki, *142*, 27: 1; 24. (397) Malarski and Marchlewski, *205*, 21: 523; 09. (398) Malarski and Marchlewski, *205*, 24: 319; 10. (399) Malarski and Marchlewski, *205*, 27: 246; 10.
- (400) Malarski and Marchlewski, *205*, 42: 219; 12. (401) Malarski and Marchlewski, *205*, 57: 112; 13. (402) Marchlewski, *205*, 3: 287; 07. (403) Marchlewski, *205*, 3: 320; 07. (404) Marchlewski, *Die Chemie der Chlorophylle*, Braunschweig, 1909. (405) Marchlewski, *205*, 43: 234; 12. (406) Marchlewski, *561*, 4: 476; 22. (407) Marchlewski, *561*, 6: 464; 24. (408) Marchlewski and Retinger, *205*, 10: 437; 08. (409) Marchlewski and Robel, *25*, 43: 260; 10.
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- (440) Meyer, M., *25*, 47: 1161; 14. (441) Meyer, R., and Fischer, *25*, 44: 1944; 11. (442) Meyer, R., and Fischer, *25*, 46: 70; 13. (443) Meyer, R., and Fischer, *25*, 46: 85; 13. (444) Meyer, R., and Marx, *25*, 40: 3603; 07. (445) Meyer, R., and Marx, *25*, 41: 2446; 08. (446) Miethe, *317*, 26: 54; 03. (447) Miethe and Stenger, *99*, 19: 57; 19. (448) Mills, *4*, 121: 455; 22. (449) Mills and Braunholtz, *4*, 123: 2804; 23.
- (450) Mills and Odams, *4*, 125: 1913; 24. (451) Mills and Raper, *4*, 127: 2466; 25. (452) Milroy, *289*, 38: 384; 09. (453) Milroy, *230*, 12: 318; 18. (454) Moir, *557*, 7: 5; 18. (455) Moir, *557*, 7: 111; 18. (456) Moir, *557*, 7: 123; 18. (457) Moir, *557*, 7: 183; 19. (458) Moir, *557*, 8: 41; 19. (459) Moir, *557*, 8: 42; 19.
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- (470) Moir, *557*, 11: 91; 23. (471) Moir, *4*, 123: 2792; 23. (472) Moir, *4*, 127: 2338; 25. (473) Moir, *557*, 13: 131; 26. (474) Moir, *4*, 1927: 1809. (475) Moir, *557*, 14: 301; 27. (476) Moir, *557*, 14: 233; 27. (477) Moir, *557*, 16: 121; 28. (478) Molisch, *Die Purpurbacterien*. Jena, 1907. (479) Monteverde and Luybimenko, *134*, 7: 1105; 13.
- (480) Newcomer, *141*, 37: 465; 19. (481) Nichols and Merritt, *2*, 19: 18; 04. (482) Nichols and Merritt, *2*, 31: 376; 10. (483) Niemann, *202*, 146: 181; 25. (484) Oesterle and Tisza, *293*, 245: 534; 07. (485) Okunev, *205*, 193: 70; 28. (486) Orndorff and Allen, *1*, 37: 1244; 15. (487) Orndorff and Barnett, *1*, 46: 2483; 24. (488) Orndorff and Hitch, *1*, 36: 707; 14. (489) Orndorff, Gibbs and McNulty, *1*, 47: 2767; 25.
- (490) Orndorff, Gibbs and McNulty, *1*, 48: 1994; 26. (491) Orndorff, Gibbs, McNulty and Shapiro, *1*, 49: 1545; 27. (492) Orndorff, Gibbs, McNulty and Shapiro, *1*, 49: 1541; 27. (493) Orndorff, Gibbs and Shapiro, *1*, 48: 1327; 26. (494) Orndorff, Gibbs and Shapiro, *1*, 50: 819; 28. (495) Orndorff and McNulty, *1*, 49: 1588; 27. (496) Orndorff and Teeple, *1*, 33: 215; 05. (497) Ostwald, *7*, 9: 579; 92. (498) Ostwald, *287*, 10: 179; 19. (499) Paladino, *Beitr. chem. Physiol. Path.*, *11*: 65; 08.
- (500) Palkin, *45*, 15: 379; 23. (501) Palkin and Wales, *1*, 46: 1488; 24. (502) Palkin and Wales, *1*, 47: 2005; 25. (503) Papendieck, *202*, 140: 16; 24. (504) Papendieck, *202*, 152: 215; 26. (505) Papendieck and Bonath, *202*, 144: 60; 25. (506) Partos, *205*, 105: 49; 20. (507) Peyrega and Vlès, *34*, 154: 133; 12. (508) Pfäuger, *8*, 65: 173; 98. (509) Pfäuger, *8*, 12: 430; 03. (510) Pfund, *172*, 20: 279; 12. (511) Pfund, *99*, 12: 341; 13. (512) Phillips, Clark and Cohen, *231*, Suppl. No. 61: 27. (513) Phillips and Goss, *1*, 48: 823; 26. (514) Piccard, *1*, 48: 2352; 26. (515) Piettre, *34*, 146: 786; 08. (516) Pihlblad, *7*, 81: 417; 12. (517) Pilotty, Stock and Dorman, *25*, 47: 1124; 14. (518) Plaats, *8*, 47: 429; 15. (519) Plotnikow, *7*, 79: 357; 12.

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- (530) Pummerer and Rebmann, 25, 61: 1099; 28. (531) Purvis, 4, 97: 2535; 10. (532) Purvis, 4, 105: 590; 14. (533) Purvis, 4, 107: 660; 15. (534) Purvis and McClelland, 4, 101: 514; 12. (535) Quagliariello, *Arch. sci. biol.*, 3: 35; 22. (536) Quagliariello, *Pubbl. staz. zool. Napoli, Ric. fisiol. chim. biol.*, 1: 57; 22. (537) Regnier, 206, 95: 77; 26. (538) Reinhard, 223, 11: 1; 27. (539) Reitzenstein and Bönitsch, 52, 86: 1; 12.
- (540) Reitzenstein and Breuning, 13, 372: 257; 10. (541) Reitzenstein and Schwerdt, 52, 75: 369; 07. (542) Reitzenstein and Stamm, 52, 81: 150; 10. (543) Robertson, 4, 103: 1473; 13. (544) Robertson and Brady, 4, 103: 1479; 13. (545) Rodio, 22, 1: 188; 25. (546) Rohn, 8, 38: 987; 12. (547) Romieu and Obata, 34, 175: 51; 22. (548) Rost, Franz and Heise, 291, 31: 223; 09. (549) Sando, *Am. J. Botany*, 6: 242; 19.
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- (570) Schumm, 202, 150: 276; 25. (571) Schumm, 202, 152: 1; 26. (572) Schumm, 202, 152: 55; 26. (573) Schumm, 202, 152: 147; 26. (574) Schumm, 202, 153: 225; 26. (575) Schumm, 202, 156: 268; 26. (576) Schumm, 202, 159: 194; 26. (577) Schumm, 202, 164: 143; 27. (578) Schumm, 202, 169: 52; 27. (579) Schumm and Mertens, 202, 156: 61; 26.
- (580) Schumm and Papendieck, 202, 159: 190; 26. (581) Scott and French, *Military Surgeon*, Sept., 1924. (582) Semper, 13, 381: 234; 11. (583) Shaeffer, Paulus and Jones, 1, 37: 776; 15. (584) Shapiro, 1, 50: 1772; 28. (585) Sheard, Baldes, Mann and Bollman, 131, 76: 577; 26. (586) Sheard, Mann and Bollman, 131, 81: 774; 27. (587) Sheppard, 204, 48: 300; 08. (588) Sheppard, 5, 82: 256; 09. (589) Shibata, 558, 1: 106; 23.
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- (630) Venable, 48, 10: 133; 25. (631) Ville and Derrien, 34, 140: 1195; 05. (632) Vlès, 34, 169: 303; 19. (633) Vlès, 561, 2: 125; 20. (634) Vlès, 561, 2: 223; 20. (635) Vlès, 34, 185: 644; 27. (636) Vlès and Gex, 34, 185: 946; 27. (637) Vogel, 8, 43: 449; 91. (638) Vogt, 7, 132: 101; 28. (639) Volta and Viterbi, *Boll. soc. ital. biol. sper.*, 2: 431; 27.
- (640) Wahl and Bagard, 27, 15: 336; 14. (641) Wahl and Faivret, 14, 5: 314; 26. (642) Wales, 1, 45: 2420; 23. (643) Wales and Palkin, 1, 48: 810; 26. (644) Watson and Meek, 4, 107: 1567; 15. (645) Watson, Sen and Medhi, 4, 107: 1477; 15. (646) Weber, *Z. biol. Tech. Methodik*, 2: 29; 10. (647) Weigert, 25, 49: 1496; 16. (648) Wick, 2, 24: 356; 07. (649) Willgerodt and Maffezzoli, 52, 82: 205; 10.
- (650) Wille, *Ber. botan. Ges.*, 40: 188; 22. (651) Willstätter and Asahina, 13, 385: 188; 11. (652) Willstätter and Benz, 13, 358: 267; 08. (653) Willstätter and Bolton, 13, 408: 42; 15. (654) Willstätter and Escher, 202, 64: 47; 10. (655) Willstätter and Escher, 202, 76: 214; 12. (656) Willstätter and Everest, 13, 401: 189; 13. (657) Willstätter and Fischer, 202, 87: 423; 13. (658) Willstätter and Fritzsche, 13, 371: 33; 09. (659) Willstätter and Mallison, 13, 408: 15; 15.
- (660) Willstätter and Mieg, 13, 408: 61; 15. (661) Willstätter and Pfannenstiel, 13, 358: 205; 08. (662) Willstätter and Stoll, *Untersuchungen über Chlorophyll*. Berlin, 1913. (663) Willstätter, Stoll and Utzinger, 13, 385: 156; 11. (664) Willstätter, Zechmeister and Kindler, 25, 57: 1938; 24. (665) Willstätter and Zollinger, 13, 408: 83; 15. (666) Winther, 9, 19: 389; 13. (667) Wise and Adams, 45, 10: 801; 18. (668) Wise and Adams, 45, 11: 460; 19. (669) Wolff, 91, 17: 65; 78.
- (670) Yaoi and Tamiya, 543, 4: 436; 28. (671) Zaleski, 25, 46: 1687; 13. (672) Zaleski, 53, 48: 1337; 16. (673) Zechmeister and Chohnoky, 13, 454: 54; 27. (674) Zeynek, 75, 121: 1495; 12. (675) Zeynek, 75, 121: 1539; 12. (676) Zilner, 205, 192: 118; 28. (677) Holmes, 0.

VISCOSITY OF PURE LIQUIDS

F. GIORDANI

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A-TABLE, ELEMENTARY SUBSTANCES

$100\eta_t = \frac{a}{1 + 10^{-3}bt + 10^{-6}ct^2}$					
Br ₂ (84)		Cl ₂ —(Cont'd)		S (37)	
<i>t</i> , °C	100 η	<i>t</i> , °C	100 η	<i>t</i> , °C	100 η
-2.6	1.287*	-35.4	0.494	123	10.94
+7	1.136	-33.8	0.489	135.5	8.66
13.6	1.058	a = 0.385		149.5	7.09
19.5	0.995	b = 5.878		156.3	7.19
27	0.925	c = -3.92		158.8	7.59
31.4	0.901			159.2	9.48
-4.3	1.311†	H ₂ (94)		159.5	14.45
+4.9	1.164	-252.57	0.0130	160	22.83
12.6	1.071	I ₂ (84)		160.3	77.32
19.1	1.003	116	2.268	165	500
a = 1.241		116.6	2.246	171	4 500
b = 12.257		121.9	2.157	184	16 000
c = 8.721		122.8	2.180	190.5	19 700
* Purified with KOH.		128.7	2.080	197.5	21 300
† Prepared from pure		136.1	1.979	200	21 500
KBr.		142.7	1.870	210	20 500
		147.8	1.822	217	19 100
		149	1.813	222	18 600
		152.5	1.770		
		157.7	1.716	121	9.94
		158.9	1.688		9.92 *
		169.8	1.572		11.4 †
		171.4	1.545		10.27 ‡
		178.7	1.462		
		a = 9.68			
		b = 21.833			
		c = 52.01			
		O ₂ (96%) (95)			
		-252.07	0.189		

* After 1 hour standing at 121°.

† After many hours standing at 200° and subsequent cooling to 121°.

‡ After further standing 1 hour at 121°.

B-TABLE, STANDARD ARRANGEMENT (v. Vol. III, p. viii)

H ₂ O		SbBr ₃ (57)		PbCl ₂ (63)	
v. Vol. V, p. 10		<i>t</i> , °C	100 η	<i>t</i> , °C	100 η
SO ₂ (38)		95	3.31	498	5.53
<i>t</i> , °C	100 η	100	3.12	508	5.06
-33.5	0.5508	BiCl ₃ (4)		518	4.66
-10.5	0.4285	260	32.0	528	4.30
0.1	0.3936	270	29.5	538	4.02
H ₂ SO ₄		280	27.0	548	3.78
v. Vol. V, p. 11		290	25.0	558	3.59
N ₂ O ₄ (91)		300	23.0	568	3.42
0.72	0.5220	310	21.5	578	3.28
5.09	0.4954	320	20.5	588	3.16
9.15	0.4720	330	19.0	598	3.06
11.87	0.4578	340	18.0	608	2.95
15.36	0.4401	CO ₂		PbBr ₂ (63)	
$\eta_t = \frac{28.155}{(140.89 + t)^{1.7349}}$		v. Vol. V, p. 11		372	10.2
NH ₃		For other C-compounds, v. the C-Table <i>infra</i>		382	8.80
-33.5	0.254 (34)	SnCl ₄ (56)		392	8.06
-33.5	0.266 (38)	25	0.919	402	7.47
NOCl (15)		30	0.806	412	6.97
-33.3	0.642	40	0.725	422	6.53
-29.5	0.604	50	0.668	432	6.13
-27	0.586	70	0.60	442	5.74
-25.2	0.567			452	5.38
-20	0.547			462	5.03
				472	4.70
				482	4.38
				492	4.07

HgBr ₂ (8)		LiNO ₃ —(Cont'd)		KOH—(Cont'd)	
<i>t</i> , °C	100 η	<i>t</i> , °C	100 η	<i>t</i> , °C	100 η
240	3.31	317.5	3.49	500	1.3
247	2.97	319	3.48	550	1.0
258	1.97	320	3.47	600	0.8
HgI ₂ (8)		NaOH (3)		KCl (61)	
258	3.54	350	4.0	790	1.42
AgCl (62)		400	2.8	835	1.21
603	1.60	450	2.2	920	0.99
632	1.46	500	1.8	1035	0.71
669	1.37	NaCl (61)		KBr (61)	
734	1.18	841	1.30	745	1.48
AgBr (62)		850	1.20	775	1.34
609	1.86	896	1.01	805	1.19
649	1.66	NaBr (61)		KNO ₃ (63)	
688	1.49	762	1.42	333	2.97
770	1.22	766	1.35	343	2.83
803	1.19	780	1.28	353	2.69
AgI (62)		NaNO ₃ (63)		363	2.56
605	3.02	308	2.92	373	2.44
611	2.85	318	2.78	383	2.33
630	2.75	328	2.66	393	2.21
698	2.37	338	2.54	403	2.11
730	2.12	348	2.44	413	2.01
792	1.85	358	2.33		
806	1.68	368	2.24		
827	1.55	378	2.14		
AgNO ₃ (40)		388	2.06		
244	3.77	398	1.98		
265	3.27	408	1.90		
275	3.04	418	1.83		
309	2.61				
342	2.29				
B ₂ O ₃ (2)					
750	43 600				
800	26 000				
850	17 000				
900	11 800				
950	9 000				
1 000	7 000				
1 050	5 300				
1 100	4 000				
LiNO ₃ (40)					
259	5.58				
269	5.10				
274	4.85				
284	4.50				
310	3.69				

C-TABLE; C-ARRANGEMENT (v. Vol. III, p. viii)

A, B, *n* are the coefficients in the formula $\eta = \frac{A}{(B + t)^n}$

CCl₄ (91), Carbon tetrachloride

<i>t</i> , °C	100 η	<i>t</i> , °C	100 η	A = 32.780
0.60	1.3322	42.08	0.7198	B = 95.05
7.15	1.8884	49.51	0.6567	<i>n</i> = 1.7121
14.89	1.0476	56.29	0.6078	
21.21	0.9517	62.87	0.5659	
27.56	0.8705	69.89	0.5246	
35.21	0.7855	74.16	0.5017	

(60)

<i>t</i> , °C	100 η
25	0.8876

CS ₂ (91)	
Carbon disulfide	
<i>t</i> , °C	100 η
0.4	0.428
4.88	0.413
9.45	0.397
14.91	0.381
19.94	0.367
25.34	0.356
30.30	0.342
35.51	0.328
40.60	0.317
45.96	0.306
A = 24.379	
B = 199.17	
<i>n</i> = 1.6328	

CHBr ₃	
Bromoform	
(8)	
6.4	2.381
(20)	
10	2.217
76.5	1.009

CHCl ₃	
Chloroform	
<i>v. Vol. V, p. 11</i>	

HCN (102)	
Hydrogen cyanide	
-7.5	0.259
+5.0	0.232
10.8	0.218
15.1	0.211
20.2	0.201

CH ₂ Br ₂ (26)	
Methylene bromide	
25	0.1225

CH ₂ Cl ₂ (91)	
Methylene chloride	
0.46	0.5329
5.73	0.5023
10.18	0.4794
15.45	0.4545
20.53	0.4330
25.59	0.4137
30.98	0.3933
37.51	0.3707
A = 5.8768	
B = 128.88	
<i>n</i> = 1.4408	

CH ₂ O ₂ (91); cf. (10, 68, 82)	
Formic acid	
7.59	2.385
15.96	1.951
24.16	1.635
32.86	1.379
40.36	1.208
48.03	1.064
56.30	0.937
64.20	0.838
72.05	0.754
80.22	0.681
97.23	0.558

CH ₂ O ₂ —(Cont'd)	
A = 32.8143	
B = 59.799	
<i>n</i> = 1.7164	
CH ₃ I (91); cf. (39)	
Methyl iodide	
<i>t</i> , °C	100 η
0	0.593
0.42	0.5914
6.06	0.5576
10.53	0.5330
15.81	0.5064
21.37	0.4810
27.22	0.4564
33.38	0.4323
39.96	0.4090
A = 6.6577	
B = 134.32	
<i>n</i> = 1.4329	

CH ₃ NO (20)	
Formamide	
0	7.552
76.5	1.254
(68)	
25	3.359
40	2.379
(27)	
105	0.768
120	0.659
A = 874	
B = 60.78	
<i>n</i> = 2.2780	

CH ₃ NO ₂ (18)	
Nitromethane	
25	0.619
0	0.843
25	0.631
40	0.526
55	0.450
70	0.392
85	0.342
(74)	

CH ₄ O	
Methyl alcohol	
<i>v. Vol. V, p. 11</i>	

CH ₃ N (38)	
Methylamine	
0	0.2364

C ₂ Cl ₄ (91)	
Tetrachloroethylene	
0	1.133
11.24	0.986
22.30	0.869
32.34	0.784
42.78	0.707
52.68	0.645
64.14	0.585
74.67	0.536
85.75	0.491
95.60	0.455
106.03	0.422
117.09	0.390

C ₂ Cl ₄ —(Cont'd)	
A = 30.656	
B = 126.17	
<i>n</i> = 1.6325	
<i>t</i> , °C	100 η
25	0.841
50	0.656
75	0.534

C ₂ Cl ₆	
Hexachloroethane	
(79)	
25	2.26

C ₂ HBr ₃ O (33)	
Bromal	
25	5.31
40	3.725
50	3.026
60	2.501
70	2.081
85	1.607
100	1.264

C ₂ HCl ₃ (44)	
Trichloroethylene	
25	0.550
50	0.446
75	0.371

C ₂ HCl ₃ O (33)	
Chloral	
25	0.1263
40	1.01
50	0.87
70	0.68
85	0.56

C ₂ HCl ₃ O ₂ (49)	
Trichloroacetic acid	
60	3.97
70	3.15

C ₂ HCl ₅ (79)	
Pentachloroethane	
0	3.73
25	2.26
(44)	
25	2.176
50	1.480
75	1.061

C ₂ H ₂ Br ₂ (91)	
1, 2-Acetylene dibromide	
0.86	1.217
10.95	1.070
19.93	0.960
30.14	0.859
39.49	0.782
47.80	0.722
57.96	0.659
67.19	0.610
76.72	0.565
85.95	0.525
97.10	0.483
105.72	0.454
A = 14.868	
B = 112.29	
<i>n</i> = 1.5032	

C ₂ H ₂ Cl ₂ (44)	
<i>cis</i> -1, 2-Acetylene dichloride	
<i>t</i> , °C	100 η
25	0.391

C ₂ H ₂ Cl ₂ (44)	
<i>trans</i> -1, 2-Acetylene dichloride	
25	0.4564
50	0.3685

C ₂ H ₂ Cl ₄ (17*)	
1, 1, 2, 2-Tetrachloroethane	
0	2.656
10	2.147
15	1.952
25	1.637
35	1.389
50	1.132
(44)	
75	0.8185
(20)	
80	0.763

* 1/ η _{<i>t</i>} = 0.13796 × [1 + 0.019171 <i>t</i> + 0.00000925 <i>t</i> ²] × (273.1 + <i>t</i>).	
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C ₂ H ₃ Br ₃ O ₂ (33)	
Bromal hydrate	
40	46.14
50	20.69
60	10.9
70	6.349
85	5.166
100	2.00

C ₂ H ₃ N (78)	
Acetonitrile	
25	0.36

C ₂ H ₄ Br ₂	
Ethylene bromide	
(91)	
9.49	2.053
20.63	1.698
31.21	1.445
41.64	1.252
51.81	1.099
62.87	0.967
73.48	0.862
85.97	0.762
95.81	0.694
105.71	0.634
117.01	0.577
126.71	0.532
A = 30.535	
B = 80.802	
<i>n</i> = 1.6222	

C ₂ H ₄ Cl ₂ (91)	
1,1-Dichloroethane	
7.06	0.5686
11.24	0.5413
15.34	0.5156
19.31	0.4934
23.22	0.4736
27.85	0.4506
31.55	0.4337

C ₃ H ₄ Cl ₂ —(Cont'd)	
<i>t</i> , °C	100 η
35.61	0.4160
40.18	0.3976
43.74	0.3836
47.95	0.3695
54.54	0.3476
A = 22.247	
B = 132.02	
<i>n</i> = 1.6762	

C ₂ H ₄ Cl ₂ (91)	
Ethylene chloride	
0.31	1.1211
7.23	1.0021
14.73	0.8961
21.84	0.8129
28.78	0.7417
36.88	0.6695
43.89	0.6166
51.74	0.5668
58.53	0.5239
65.53	0.4912
72.95	0.4558
81.07	0.4217
A = 24.256	
B = 100.67	
<i>n</i> = 1.6641	

C ₂ H ₄ O (91)	
Acetaldehyde	
0.33	0.2663
5.35	0.2538
9.56	0.2442
13.92	0.2345
19.17	0.2234
A = 15652.2	
B = 286.11	
<i>n</i> = 2.7550	

C ₂ H ₄ O (64)	
Ethylene oxide	
-49.8	0.5772
-45.7	0.5387
-38.2	0.4883
-32.6	0.4505
-21	0.3937
-13.6	0.3637
0	0.3202
+ 9.3	0.2927

C ₂ H ₄ O ₂ (91)	
Acetic acid	
30.86	1.025
39.88	0.903
48.47	0.806
57.46	0.721
68.10	0.638
76.66	0.580
84.53	0.534
93.97	0.484
102.89	0.445
112.57	0.406
A = 267.814	
B = 112.207	
<i>n</i> = 2.0492	

C ₂ H ₄ O ₂ —(Cont'd)	
<i>t</i> , °C	100 η
(13*)	
25	1.148
35	0.991
45	0.865
55	0.760
65	0.676
75	0.607
85	0.546
95	0.489
(39)	
20	1.234
(49)	
25	1.121
* 1/ η _{<i>t</i>} = 0.2072 [1 + 0.01597 <i>t</i> + 0.0000178 <i>t</i> ²] × (273.1 + <i>t</i>).	

C ₂ H ₄ O ₂ (92)	
Methyl formate	
0.58	0.4263
6.39	0.3999
10.88	0.3809
15.63	0.3626
20.15	0.3467
25.52	0.3298
29.25	0.3190
A = 0.144673	
B = 68.234	
<i>n</i> = 0.8325	
(39)	
20	0.367

C ₂ H ₅ Br (91)	
Ethyl bromide	
0.34	0.4759
5.18	0.4525
9.67	0.4327
15.46	0.4087
20.54	0.3903
25.28	0.3734
30.03	0.3581
36.15	0.3394

A = 6.8898	
B = 138.65	
n = 1.4749	
(46)	
19.2	0.3973
19.9	0.3968
46	0.3037
77	0.2326

C₂H₅I. —(Cont'd)		C₃H₅Br. —(Cont'd)		C₃H₆Br₂ (26)		C₃H₆O. —(Cont'd)		C₃H₆O₂. —(Cont'd)		C₃H₇Cl (91)	
, °C 100η		t, °C 100η		1, 3-Dibromopropane		t, °C 100η		t, °C 100η		Isopropyl chloride	
(79)										t, °C 100η	
0	0.725	61.15	0.3402	25	1.797	40	0.271	28.38	0.3492	0.27	0.4000
C₂H₅NO (27)		A = 30.360		C₃H₆Cl₂ (26)		50	0.249	33.85	0.3304	6.68	0.3714
Acetamide		B = 145.03		1, 3-Dichloropropane		(1)		40.45	0.3100	11.02	0.3540
105	1.32	n = 1.7075		C₃H₆O (91)		0	0.389	46.06	0.2942	16.47	0.3341
120	1.06	C₃H₅Cl (91)		Allyl alcohol		−10.6	0.451	50.34	0.2828	22.50	0.3137
C₂H₅NO₂ (81)		3-Chloropropylene		7.41 1.810		−20.4	0.516	54.33	0.2727	28.22	0.2962
Methyl carbamate		0.53 0.4035		15.31 1.508		−30.3	0.613	A = 57.4012		33.02	0.2829
55.6	2.28	5.98 0.3800		22.81 1.283		−40	0.713	B = 154.499		A = 9.2541	
74.6	1.37	11.19 0.3598		30.50 1.096		−49.9	0.818	n = 1.8636		B = 133.60	
82.2	1.24	16.66 0.3408		38.05 0.946		−59.7	0.981	(39)		n = 1.5819	
99	0.85	21.93 0.3230		46.36 0.811		−69.7	1.200	20	0.3831		
C₂H₆O		28.32 0.3039		54.10 0.708		−79.7	1.505	C₃H₆O₃ (23)		C₃H₇I (91)	
Ethyl alcohol		33.97 0.2885		60.77 0.633		−89.7	2.051	Lactic acid		n-Propyl iodide	
v. Vol. V, p. 11		38.37 0.2774		68.86 0.557		C₃H₆O₂ (91)		25	40.5	0.30	0.934
C₂H₆O₂ (23)		42.10 0.2681		76.81 0.492		Propionic acid		C₃H₇Br (91)		10.98	0.817
Glycol		A = 27.705		84.50 0.440		4.70	1.404	n-Propyl bromide		20.81	0.730
25	17.4	B = 157.08		92.26 0.394		16.87	1.151	0.45	0.6414	28.31	0.673
C₂H₆O₄S (20)		n = 1.7549		95.24 0.379		28.21	0.979	7.86	0.5884	38.83	0.605
Dimethyl sulfate		C₃H₅ClO (18)		A = 10748.4		40.04	0.839	13.66	0.5523	46.17	0.564
0	2.732	α-Epichlorohydrin		B = 109.42		52.03	0.729	19.17	0.5209	55.59	0.516
76.5	0.802	25 1.03		n = 2.7925		63.63	0.642	25.44	0.4903	65.46	0.474
C₂H₆S (91)		C₃H₅I (91)		(23)		76.70	0.562	31.88	0.4588	74.38	0.439
Methyl sulfide		3-Iodopropylene		25 1.237		89.56	0.496	38.60	0.4300	83.88	0.406
0.27	0.3529	0.33 0.926		C₃H₆O (18)		101.01	0.448	45.64	0.4032	90.78	0.384
5.56	0.3351	9.33 0.825		Propionaldehyde		112.98	0.403	51.01	0.3844	98.89	0.362
10.05	0.3209	16.77 0.754		25 0.435		123.67	0.368	57.37	0.3633	A = 50.893	
14.75	0.3075	26.12 0.679		(96)		137.05	0.329	61.98	0.3495	B = 136.84	
20.19	0.2927	35.77 0.614		0 0.467		A = 105.746		67.86	0.3328	n = 1.7483	
26.14	0.2776	44.18 0.565		25 0.344		B = 109.53		A = 65.713		C₃H₇I (91)	
31.35	0.2655	55.16 0.510		C₃H₆O (91)		n = 1.8840		B = 155.75		Isopropyl iodide	
35.81	0.2559	63.44 0.476		Acetone		(39)		n = 1.8282		0.30	0.875
A = 21.768		71.14 0.443		7.86 0.3638		20 1.109		C₃H₇Br (91)		9.18	0.782
B = 170.34		81.29 0.410		11.72 0.3495		C₃H₆O₂ (92)		Isopropyl bromide		15.92	0.722
n = 1.6981		91.86 0.375		15.24 0.3376		Ethyl formate		0.33	0.6021	23.43	0.664
C₂H₆S (22)		98.45 0.358		19.02 0.3258		0.46	0.5024	5.12	0.5688	32.69	0.601
Ethylmercaptan		A = 28.411		23.01 0.3131		6.57	0.4656	10.14	0.5371	40.67	0.555
25	0.210	B = 126.05		27.22 0.3007		11.52	0.4409	15.30	0.5068	49.43	0.509
C₂H₇N (34)		n = 1.6592		32.43 0.2863		16.58	0.4171	20.28	0.4803	57.01	0.475
Dimethylamine		C₃H₅N (96)		36 0.2772		22.59	0.3910	25.46	0.4551	65.44	0.440
−33.5	0.3208	Propionitrile		40.04 0.2675		27.90	0.3699	29.94	0.4343	71.49	0.418
C₂H₇N (34)		0 0.541		44.12 0.2584		33.25	0.3501	35.90	0.4095	80.45	0.388
Ethylamine		25 0.413		47.62 0.2503		38.09	0.3344	41.17	0.3894	88.72	0.361
−33.5	0.4368	C₃H₅NS (96)		52.20 0.2405		43.36	0.3178	46.36	0.3704	A = 129.85	
C₂H₈N₂ (26)		Ethyl thiocyanate		53.86 0.2377		48.61	0.3030	50.91	0.3555	B = 150.03	
Ethylenediamine		0 1.105		A = 572.63		52.03	0.2942	56.76	0.3371	n = 1.9161	
25	1.54	25 0.779		B = 209.08		A = 22.2406		A = 188.08		C₃H₇N (72)	
C₃H₂N₂ (103)		C₃H₆Br₂ (91)		n = 1.7006		B = 139.932		B = 169.03		Allylamine	
Malonic nitrile		1, 2-Dibromopropane		(39)		n = 2.2244		n = 2.0166		25	0.3745
32.68	2.85	0.36 2.285		A = 572.63		20 0.4132		C₃H₇Cl (91)		C₃H₇NO (27)	
50	2.15	12.91 1.816		B = 209.08		(58)		n-Propyl chloride		Propionamide	
C₃H₅Br (91)		25.27 1.494		n = 2.2244		25	0.389	0.45	0.4327	105	1.27
3-Bromopropylene		38.02 1.247		(21)		30	0.375	5.24	0.4104	120	1.03
0.30	0.6168	50.08 1.072		10 0.362		40	0.345	10.06	0.3894	C₃H₇NO₂ (85)	
6.64	0.5730	63.19 0.918		20 0.331		50	0.311	14.65	0.3709	Urethane	
12.42	0.5372	76.46 0.797		(6)		(31)		20.71	0.3495	60	2.357
18.34	0.5046	89.13 0.704		0 0.399		25	0.379	25.76	0.3344	70	1.805
24.73	0.4727	101.18 0.628		15 0.345		C₃H₆O₂ (92)		30.38	0.3178	80	1.456
30.84	0.4449	113.71 0.565		25 0.316		Methyl acetate		35.38	0.3038	(27)	
37.22	0.4198	127.97 0.501		(14)		0.34	0.4762	40.82	0.2887	105	0.916
42.84	0.3988	136.67 0.468		0 0.397		6.31	0.4436	44.68	0.2784	120	0.715
47.86	0.3805	A = 48.803		10 0.361		11.41	0.4186	A = 662.52			
54.55	0.3587	B = 88.757		20 0.325		16.70	0.3948	B = 203.36			
		n = 1.7075		30 0.296		22.74	0.3706	n = 2.2453			

C ₃ H ₈ O (91)	
<i>n</i> -Propyl alcohol	
<i>t</i> , °C	100 η
7.35	3.145
15.06	2.555
22.86	2.101
30.83	1.732
31.02	1.724
38.79	1.440
46.47	1.218
54.33	1.030
61.74	0.888
69.04	0.771
76.75	0.666
84.82	0.576
93.10	0.499
95.59	0.477
A = 8 801 350	
B = 135.75	
<i>n</i> = 3.9188	
(39)	
10	2.877
20	2.230
30	1.756
40	1.389
50	1.125
(73)	
0	4.137
13.4	2.868

C ₃ H ₈ O (91)	
Isopropyl alcohol	
0.36	4.5018
7.21	3.5568
14.41	2.8157
22.22	2.2204
30.55	1.7275
37.92	1.4053
A = 2 175 320 000	
B = 141.72	
<i>n</i> = 4.9635	
(91)	
45.15	1.1604
51.97	0.9770
59.39	0.8157
66.60	0.6923
72.02	0.6141
78.09	0.5407
A = 192 398	
B = 86.259	
<i>n</i> = 3.4079	
(39)	
10	3.319
20	2.431
30	1.810
40	1.375
50	1.063
(29)	
20	2.19
25	1.95
30	1.74

C ₃ H ₈ O ₂ (39)	
1, 2-Propyleneglycol	
20	44.80

C ₃ H ₉ N (72)	
<i>n</i> -Propylamine	
<i>t</i> , °C	100 η
25	0.353
C ₃ H ₉ N (34)	
Trimethylamine	
-33.5	0.3208
C ₃ H ₁₀ N ₂ (26)	
Trimethylenedi- amine	
25	1.81
C ₄ H ₄ S (91)	
Thiophene	
0.24	0.8676
8.39	0.7692
16.61	0.6876
22.50	0.6384
31.12	0.5754
37.83	0.5328
44.94	0.4934
53.08	0.4540
61.66	0.4170
68.60	0.3907
75.06	0.3682
82.53	0.3447
A = 15.677	
B = 105.87	
<i>n</i> = 1.6078	

C ₄ H ₅ NS (59)	
Allyl thiocyanate	
25	0.673
50	0.541
80	0.427
(57.5)	
100	0.316
125	0.263

C ₄ H ₆ O ₂ (88)	
Trimethylenecarboxylic acid	
25	2.98

C ₄ H ₆ O ₃ (91)	
Acetic anhydride	
0.18	1.238
12.52	1.007
24.10	0.852
35.40	0.734
48.15	0.630
60.39	0.551
71.04	0.494
84.42	0.434
95.09	0.394
108.92	0.351
120.23	0.320
133.39	0.289
A = 27.713	
B = 97.10	
<i>n</i> = 1.6851	
(39)	
20	0.946
(20)	
10	1.058
15	0.979
76.5	0.462

C ₄ H ₈ Br ₂ (91)	
1, 2-Dibromo-2-methylpropane	
<i>t</i> , °C	100 η
0.39	3.290
13.67	2.456
26.94	1.916
40.80	1.528
53.18	1.274
66.90	1.065
80.60	0.903
93.63	0.781
107.15	0.680
121.74	0.593
133.75	0.532
142.44	0.494
A = 79.485	
B = 75.60	
<i>n</i> = 1.7988	

C ₄ H ₈ O (91)	
Methyl ethyl ketone	
0.32	0.5361
7.04	0.4923
14.10	0.4522
21.31	0.4170
28.36	0.3861
35.42	0.3586
42.49	0.3342
48.72	0.3149
55.92	0.2944
63.74	0.2750
70.26	0.2595
76.25	0.2465
A = 36.972	
B = 139.33	
<i>n</i> = 1.7895	
(65)	
25	0.497
(39)	
20	0.442

C ₄ H ₈ O ₂ (91)	
<i>n</i> -Butyric acid	
3.21	2.128
18.02	1.591
31.83	1.263
44.49	1.049
59.39	0.860
73.36	0.727
86.55	0.628
101.55	0.537
115.24	0.470
130.26	0.408
144.97	0.358
155.76	0.327
A = 195.765	
B = 94.462	
<i>n</i> = 1.99205	
(39)	
10	1.920
20	1.599
30	1.341
40	1.160
50	1.004

C ₄ H ₈ O ₂ (91)	
Isobutyric acid	
<i>t</i> , °C	100 η
3.69	1.761
17	1.383
29.33	1.137
42.53	0.945
54.54	0.811
70.49	0.674
88.06	0.560
98.94	0.499
109.78	0.450
120.97	0.407
134.50	0.361
147.47	0.323
A = 212.41	
B = 104.63	
<i>n</i> = 2.00595	

C ₄ H ₈ O ₂ (92)	
Ethyl acetate	
0.25	0.5763
8.90	0.5144
14.46	0.4795
21.38	0.4418
28.12	0.4096
36.54	0.3738
44.12	0.3455
51.15	0.3224
60.16	0.2960
68.43	0.2741
74.60	0.2594
A = 45.322	
B = 135.423	
<i>n</i> = 1.8268	
(39)	
20	0.4521
(58)	
25	0.441
50	0.345
70	0.283
(101)	
0	0.588
(46, 47)	
20.9	4.533
46.2	3.375
77.7	2.515
99.6	2.090
(51)	
25	0.4239
(49)	
25	0.4236

C ₄ H ₈ O ₂ (92)	
Methyl propionate	
0.38	0.5788
9.73	0.5142
16.79	0.4725
23.46	0.4368
29.61	0.4098
38.66	0.3746
45.59	0.3477
52.65	0.3254
60.37	0.3028
68.49	0.2812
A = 74.898	
B = 146.621	
<i>n</i> = 1.89725	

C ₄ H ₈ O ₂ —(Cont'd)	
<i>t</i> , °C	100 η
(39)	
20	0.461
C ₄ H ₈ O ₂ (92)	
<i>n</i> -Propyl formate	
0.35	0.6647
7.33	0.6041
15.54	0.5457
23.16	0.4975
30.77	0.4558
38.53	0.4184
45.73	0.3875
54.14	0.3565
61.56	0.3315
67.13	0.3136
74.98	0.2928
77.55	0.2861

A = 35.3453	
B = 139.283	
<i>n</i> = 1.9154	
(39)	
20	0.5134

C ₄ H ₈ O ₂ (39)	
Isopropyl formate	
20	0.5649

C ₄ H ₉ Br (91)	
Isobutyl bromide	
0.34	0.820
7.40	0.745
16.08	0.669
23.71	0.611
32.17	0.556
40.34	0.510
48.39	0.470
56.14	0.435
64.17	0.404
72.57	0.373
80.18	0.348
87.93	0.323
A = 472.23	
B = 161.62	
<i>n</i> = 2.1547	

C ₄ H ₉ Cl (91)	
Isobutyl chloride	
0.35	0.5816
5.97	0.5401
11.95	0.5015
18.69	0.4637
23.47	0.4386
29.46	0.4102
37.32	0.3768
42.43	0.3575
48.71	0.3359
53.74	0.3197
60.26	0.3007
65.30	0.2877
A = 61.940	
B = 141.87	
<i>n</i> = 1.8706	

C ₄ H ₉ I (91)	
Isobutyl iodide	
0.45	1.154
11.23	0.978
22.44	0.844

C ₄ H ₉ I—(Cont'd)	
<i>t</i> , °C	100 η
33.84	0.739
44.56	0.658
54.65	0.593
65.11	0.536
77.33	0.480
86.83	0.442
97.84	0.403
109.20	0.368
116.07	0.349
A = 27.652	
B = 108.86	
<i>n</i> = 1.6577	

C ₄ H ₉ N (88)	
Tetrahydropyrrole	
25	0.697

C ₄ H ₁₀ (54)	
<i>n</i> -Butane	
-23.6	0.265
0	0.207
18.5	0.176
34.5	0.153

C ₄ H ₁₀ O (91)	
<i>n</i> -Butyl alcohol	
0.27	5.154
10.69	3.796
21.83	2.801
31.73	2.172
42.91	1.661
A = 65 187 500	
B = 139.05	
<i>n</i> = 4.2452	
52.17	1.344
61.99	1.090
72.24	0.8860
83.13	0.7183
94.88	0.5817
102.96	0.5096
114.11	0.4259
A = 117 255	
B = 91.997	
<i>n</i> = 3.2150	

C ₄ H ₁₀ O (91)	
Isobutyl alcohol	
0.45	7.9111
9.90	5.5735
19.01	3.9779
27.77	3.0658
38.16	2.2392
A = 1 486 370	
B = 92.248	
<i>n</i> = 3.6978	
47.44	1.7217
56.48	1.3571
56.59	1.3502
65.95	1.0697
74.61	0.8748
A = 1 112 440	
B = 86.751	
<i>n</i> = 3.6708	
83.95	0.7173
93.85	0.5864
105.07	0.4753

C₄H₁₀O (Cont'd)

A = 29 790.3
B = 63.14
n = 3.0537

(67)

t, °C	100η
18.8	3.93

(35)

25	3.382
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C₄H₁₀O (91)

tert-Butyl alcohol

22.41	5.887
32.08	3.004
37.22	2.367
42.41	1.909
47.82	1.550

A = 2.05152

B = -7.803

n = 1.3242

52.99 1.296

57.94 1.097

62.09 0.9678

68.35 0.8102

73.47 0.7057

77.05 0.6447

A = 46.3090

B = 5.077

n = 2.0143

C₄H₁₀O

Ethyl ether

r. Vol. V, p. 11

C₄H₁₀O (91)

Methyl propyl ether

0.30 0.3064

5.14 0.2914

10.47 0.2759

15.17 0.2630

20.10 0.2513

25.73 0.2385

29.48 0.2300

35.15 0.2187

A = 8.4251

B = 146.862

n = 1.5863

C₄H₁₀S (91)

Ethyl sulfide

0.21 0.5575

8.32 0.5064

15.85 0.4652

24.64 0.4233

32.63 0.3901

40.19 0.3623

47.75 0.3374

56.49 0.3118

63.50 0.2933

71.25 0.2749

80.31 0.2555

87.99 0.2406

A = 49.886

B = 149.15

n = 1.8175

C₄H₁₁N (72)

n-Butylamine

25 0.681

C₄H₁₁N (72)

Isobutylamine

t, °C	100η
25	0.553

C₄H₁₁N (59)

Diethylamine

25 0.346

35 0.279

25 (72) 0.367

(34)

-33.5 0.8236

C₅H₅N (14)

Pyridine

0 1.328

10 1.112

20 0.945

30 0.824

40 0.717

60 0.580

80 0.489

110 0.386

(77)

25 0.889

(27)

25 0.884

(41)

0 1.33

25.08 0.888

C₅H₈ (91)

Isoprene

0.35 0.2589

5.62 0.2459

10.27 0.2358

15.33 0.2249

20.41 0.2147

25.25 0.2060

28.94 0.1996

32.02 0.1944

29.93 0.1985

A = 3.3891

B = 144.01

n = 1.4433

C₅H₈O (88)

Cyclopentanone

25 1.07

C₅H₈O (48)

Ethyl propargyl ether

25 0.529

C₅H₈O₂ (88)

Cyclobutane-

carboxylic acid

25 2.45

C₅H₈O₃ (39)

Methyl acetoacetate

20 1.702

C₅H₁₀ (16)

Cyclopentane

0 0.572

15 0.477

20 0.456

25 0.427

30 0.406

C₅H₁₀ (91)

2-Methyl-2-butene

t, °C	100η
0.20	0.2529

5.46 0.2406

10.21 0.2306

15.82 0.2192

20.03 0.2114

25.75 0.2015

30.69 0.1931

32.59 0.1903

A = 28.916

B = 187.24

n = 1.7855

C₅H₁₀Br₂ (26)

1, 5-Dibromo-

pentane

25 0.305

C₅H₁₀Cl₂ (26)

Dichloropentane

25 1.60

C₅H₁₀O (91)

Diethyl ketone

0.46 0.5914

9.10 0.5302

18.70 0.4748

27.07 0.4328

36.21 0.3939

44.70 0.3623

53.44 0.3339

62.43 0.3079

72.20 0.2834

81.47 0.2623

90.97 0.2426

98.82 0.2279

A = 64.487

B = 146.67

n = 1.8626

(39)

20 0.4799

(88)

25 0.442

C₅H₁₀O (91)

Methyl propyl ketone

0.38 0.6404

9.40 0.5692

18.30 0.5109

27.77 0.4592

35.43 0.4234

45.29 0.3831

53.94 0.3525

62.24 0.3262

72.74 0.2980

80.64 0.2787

90.06 0.2574

98.77 0.2400

A = 51.543

B = 137.75

n = 1.8248

(88)

25 0.473

C₅H₁₀O₂ (39)

Methylethylacetic acid

t, °C	100η
20	2.055

C₅H₁₀O₂ (24)

n-Valeric acid

16.5 2.41

20 2.30

25 2.05

50 1.315

70 0.986

90 0.753

(31)

50 1.25

70 0.979

(39)

20 2.233

C₅H₁₀O₂ (93)

Isovaleric acid

20 2.411

C₅H₁₀O₂ (39)

n-Butyl formate

20 0.5627

C₅H₁₀O₂ (39)

Isobutyl formate

20 0.6650

(66)

20 0.644

C₅H₁₀O₂ (92)

Ethyl propionate

0.39 0.6890

10.09 0.6037

20.08 0.5310

29.74 0.4735

39.88 0.4230

49.68 0.3817

59.14 0.3477

69.24 0.3155

72.12 0.3073

80.14 0.2854

89.69 0.2627

A = 72.981

B = 133.905

n = 1.8914

(39)

20 0.5367

(66)

20 0.549

C₅H₁₀O₂ (92)

Methyl n-butyrate

0.32 0.7551

10.45 0.6527

20.38 0.5727

30.64 0.5049

40.58 0.4503

50.30 0.4058

60.20 0.3667

71.50 0.3295

79.45 0.3057

90.63 0.2767

98.28 0.2592

A = 53.0991

B = 123.745

n = 1.8375

C₅H₁₀O₂ (92)

Methyl isobutyrate

t, °C	100η
0.28	0.6687

9.40 0.5914

18.11 0.5299

28.98 0.4660

35.81 0.4317

44.66 0.3932

52.55 0.3631

62.72 0.3289

76.22 0.3036

79.77 0.2813

88.84 0.2588

A = 98.0935

B = 139.956

n = 1.9405

(39)

20 0.5170

C₅H₁₀O₂ (92)

n-Propyl acetate

0.38 0.7652

9.78 0.6659

20.59 0.5762

30.13 0.5108

39.75 0.4563

50.04 0.4079

61.36 0.3624

69.90 0.3331

80 0.3028

89.50 0.2775

96.90 0.2602

A = 73.6005

B = 125.269

n = 1.8972

(6)

25 0.557

(66)

20 0.592

(39)

20 0.5959

C₅H₁₀O₂ (39)

Isopropyl acetate

20 0.5247

C₅H₁₁N (88)

Piperidine

25 1.37

(59)

C₆H₁₂O.—(Cont'd)

A = 1156.78
B = 37.682
$n = 2.4618$
$80^\circ \leq t \leq 128^\circ$

C₆H₁₂O (91)

<i>tert.</i> -Amyl alcohol	
$t, ^\circ\text{C}$	100 η
0.49	13.7969
9.31	8.2034
18.48	4.9978
27.24	3.3643

A = 35.091

B = 47.922

 $n = 3.2081$ $0^\circ \leq t \leq 27^\circ$

36.42	2.3322
45.05	1.7135
53.18	1.3199
62.95	0.9943

A = 3255.20

B = 37.007

 $n = 2.7578$ $27^\circ \leq t \leq 63^\circ$

71.91	0.7931
81.06	0.6400
89.94	0.5301
95.70	0.4718
96.70	0.4643

A = 2159.86

B = 38.340

 $n = 2.6611$ $60^\circ \leq t \leq 95^\circ$

(16)	
25	3.697
40	1.975
50	1.401
70	0.798
85	0.573

C₆H₁₂O (29)

<i>sec.</i> -Amyl alcohol	
25	3.103

C₆H₁₂O (29)

Methylisopropyl carbinol	
25	3.525

C₆H₁₂O (92)

Ethyl propyl ether	
0.35	0.3952
5.65	0.3714
10.65	0.3510
15.66	0.3324
20.32	0.3165
25.34	0.3006
30.08	0.2864
35.08	0.2727
39.98	0.2598
45.62	0.2466
50.30	0.2363
55	0.2264
60.18	0.2159

A = 284.675

B = 183.355

 $n = 2.1454$ **C₆H₁₂O (92)**

Methyl isobutyl ether	
$t, ^\circ\text{C}$	100 η
0.36	0.3797
6.92	0.3526
14.51	0.3246
21.35	0.3022
28.89	0.2800
35.98	0.2620
42.55	0.2458
49.75	0.2305
55.22	0.2192

A = 122.591

B = 174.318

 $n = 2.0109$ **C₆H₁₃N (72)**

Isoamylamine	
25	0.7235

C₆H₁₃N (88)

Ethyl- <i>n</i> -propylamine	
25	0.903

C₆H₁₄N₂ (26)

Pentamethyldiamine	
25	2.36

C₆H₃N₃O₆ (57)

1, 3, 5-Trinitrobenzene	
152	1.57

C₆H₄N₂O₄ (55)

<i>m</i> -Dinitrobenzene	
90	2.53

C₆H₅Br (69)

Bromobenzene	
0.1	1.573
5.9	1.445
10.1	1.332
18.2	1.171
28.3	1.023
43.6	0.842
61.4	0.694
71.2	0.626
80.7	0.579
91	0.526
102.2	0.485
111.7	0.445
121.7	0.417
132.3	0.373
142.3	0.351

(79)

0	1.50
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C₆H₅Cl (69)	
Chlorobenzene	
0	1.053
4.7	0.988
9.7	0.917
15.9	0.848
17.6	0.827
20.1	0.800
25.1	0.751
30.2	0.704
40.2	0.629

C₆H₅Cl.—(Cont'd)

$t, ^\circ\text{C}$	100 η
49.9	0.570
60	0.513
72.1	0.460
80.4	0.428
88.1	0.393
96.2	0.369
107.8	0.344
119.6	0.307

(26)

25	0.76
20	0.77

C₆H₅ClO (14.5)

<i>o</i> -Chlorophenol	
0	10.7
10	6.39
20	4.21
30	3.08
40	2.32
60	1.51
80	1.07
110	0.76
150	0.54

(86)

45	2.291
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(90)

25	4.11
50	2.0

C₆H₅ClO (86)

<i>m</i> -Chlorophenol	
45	4.82
(90)	
25	11.5
50	4.0

C₆H₅ClO (86)

<i>p</i> -Chlorophenol	
45	6.15
(90)	
50	5.0

C₆H₅F (69)

Fluorobenzene	
9.3	0.647
15.9	0.615
19.9	0.577
29.1	0.514
33.2	0.495
38.1	0.468
44	0.438
50.2	0.412
60.5	0.370
71.9	0.334
80.9	0.305

C₆H₅I (69)

Iodobenzene	
4.6	2.207
17.4	1.780
27.5	1.504
36.8	1.316
48.1	1.135
58.1	1.005
68.2	0.902
80.6	0.792
98	0.673

C₆H₅I.—(Cont'd)

$t, ^\circ\text{C}$	100 η
107.5	0.623
117.7	0.549
126.9	0.529
137.6	0.487
148.8	0.448

C₆H₅NO₂ (9); cf. (14, 18, 19, 20, 21, 81, 89)

Nitrobenzene	
0.3	3.083
10	2.509
20	2.013
30	1.682
40	1.438
50	1.251
60	1.094
70	0.970
90	0.779
100.5	0.704

C₆H₅NO₃ (14)

<i>o</i> -Nitrophenol	
40	2.75
60	1.82
80	1.35
(86)	
45	2.388

C₆H₆

Benzene

v. Vol. V, p. 12**C₆H₆CIN (87)**

<i>o</i> -Chloroaniline	
55	1.65

C₆H₆CIN (87)

<i>m</i> -Chloroaniline	
55	1.76
(78)	
25	3.50

C₆H₆CIN (87)

<i>p</i> -Chloroaniline	
55	1.96

C₆H₆O (80)

Phenol	
18.30	12.744
20.38	11.384
25.03	8.976
29.26	7.371
35.25	5.779
38.04	5.151
39.51	4.876
40.20	4.771
49.84	3.449
55.52	2.903
60.46	2.531
66.45	2.163
70.30	1.973

(12*)

35	6.024
40	4.803
45	4.000
50	3.419
55	2.938
60	2.562

C₆H₆O.—(Cont'd)

$t, ^\circ\text{C}$	100 η
65	2.249
70	1.997
75	1.779
80	1.596
85	1.439
90	1.306
* $\eta t = \frac{(0.001511t + 0.00001075t^2 - 0.01219)}{\times (273.1 + t)}$	

C₆H₇N (36*)

Aniline	
-5.50	13.86
-0.06	10.25
0	10.24
+2.50	9.15
10.35	6.44
15.35	5.20
16.32	5.015
17.38	4.845
31.76	2.977
49.01	1.84
61.27	1.488
80.33	1.099
100.39	0.829
119.87	0.660
120	0.653

C₆H₇N (9)

0.5	10.050
10	6.491
15	5.379
20	4.429
25	3.781
30	3.221
35	2.826
45	2.158
60	1.553
80	1.094
98	0.838

* $\log (100\eta) = -1.1485 \times \left(\frac{t - 85.26}{t + 97.1} \right)$ **C₆H₇N (32)**

α -Picoline	
25	0.795

C₆H₇N (32)

β -Picoline	
25	0.876

C₆H₈N₂ (90)

Phenylhydrazine	
50	4.58

C₆H₁₀ (91)

Diisopropenyl	
0.37	0.3374
5.95	0.3169
10.78	0.3010
15.46	0.2866
20.76	0.2719
25.46	0.2599
30.71	0.2474
36.06	0.2355
41.99	0.2229

C₆H₁₀.—(Cont'd)

$t, ^\circ\text{C}$	100 η
46.76	0.2137
51.54	0.2047
56.20	0.1966
A = 72.193	
B = 173.01	
$n = 1.9340$	
(39)	
20	0.2733

C₆H₁₀O (42.5)

Cyclohexanone	
17.3	2.30
39.1	1.55
65.9	1.01
(88)	
25	2.8

C₆H₁₀O (25)

Mesityl oxide	
25	0.879

C₆H₁₀O₂ (88)

Ethyl cyclopropanecarboxylate	
25	0.98

C₆H₁₀O₃ (91)

Propionic anhydride	
0.47	1.592
14.70	1.220
29.97	0.960
44.86	0.780
59.52	0.651
74.87	0.549
94.87	0.450
104.52	0.412
119.57	0.361
134.65	0.319
148.66	0.287
164.56	0.254

A = 31.312

B = 85.011

 $n = 1.70$

C_6H_{12} (16)	
$t, ^\circ C$	100η
0	0.665
15	0.545
20	0.521
25	0.484
30	0.456

$C_6H_{12}O$ (42.5)	
Cyclohexanol	
39.1	20.3
65.9	5.8
90	2.45

$C_6H_{12}O$ (39)	
Methyl <i>n</i> -butyl ketone	
20	0.6261
(88)	
25	0.584

$C_6H_{12}O$ (39)	
Methyl isobutyl ketone	
20	0.5799

$C_6H_{12}O_2$ (39)	
Caproic acid	
20	3.198
(24)	
16.1	3.56
20	3.23
25	2.84
40	2.12
50	1.75
70	1.29
90	0.98

$C_6H_{12}O_2$ (39)	
Diethylacetic acid	
20	3.159

$C_6H_{12}O_2$ (39)	
Methylpropylacetic acid	
20	2.867

$C_6H_{12}O_2$ (66)	
Isoamyl formate	
20	0.794

$C_6H_{12}O_2$ (39)	
Isobutyl acetate	
20	0.7034
(46)	
19.9	0.724
78.1	0.366
99.4	0.287

$C_6H_{12}O_2$ (39)	
Ethyl <i>n</i> -butyrate	
20	0.6668
(66)	
20	0.668
(58)	
25	0.628
50	0.466
70	0.381

$C_6H_{12}O_2$ (39)	
Ethyl isobutyrate	
20	0.588
(88)	
25	0.557

$C_6H_{12}O_2$ (39)	
Methyl <i>n</i> -valerate	
20	0.7119

$C_6H_{12}O_2$ (39)	
<i>n</i> -Propyl propionate	
20	0.6722
(66)	
20	0.678

$C_6H_{12}O_3$ (71)	
Paraldehyde	
15	1.31
20	1.17

C_6H_{14} (16)	
Diisopropyl	
0	0.495
15	0.409
20	0.385
25	0.361
30	0.342

C_6H_{14} (13)	
<i>n</i> -Hexane	
25	0.3289
35	0.2828
50	0.2746
65	0.2177

C_6H_{14} (91)	
0.80	0.3931
9.15	0.3581
14.75	0.3378
19.98	0.3202
25.39	0.3035
30.23	0.2894
36.76	0.2722
43.47	0.2557
47.42	0.2470
52.90	0.2351
58.76	0.2231
63.59	0.2143

A = 276.01	
B = 189.42	
$n = 2.1264$	

C_6H_{14} (16)	
Isohexane	
0	0.371
15	0.324
20	0.310
25	0.295
30	0.280

C_6H_{14} (16)	
2, 2-Dimethylbutane	
0	0.477
15	0.397
20	0.375
25	0.351
30	0.330

C_6H_{14} (91)	
2-Methylpentane	
0.61	0.3688
5.59	0.3487
10.25	0.3316
15.26	0.3147
20.51	0.2987
25.45	0.2841
31.97	0.2670
36.63	0.2550
41.07	0.2450
45.38	0.2355
51.17	0.2235
55.43	0.2151
A = 917.96	
B = 209.35	
$n = 2.3237$	

C_6H_{14} (16)	
3-Methylpentane	
0	0.394
15	0.339
25	0.307
30	0.292

$C_6H_{14}O$ (30)	
Ethylisopropyl carbinol	
25	4.05

$C_6H_{14}O$ (31)	
Hexyl alcohol	
25	0.437
50	0.216

$C_6H_{14}O$ (30)	
Methylbutyl carbinol	
25	3.99

$C_6H_{14}O$ (92)	
Ethyl isobutyl ether	
0.36	0.4803
7.34	0.4397
15.10	0.4003
21.70	0.3709
28.14	0.3454
35.39	0.3200
41.76	0.2996
48.97	0.2791
55.99	0.2615
63.17	0.2440
70.66	0.2280
77.48	0.2147
A = 98.4046	
B = 152.69	
$n = 1.9733$	

$C_6H_{14}O$ (92)	
Propyl ether	
0.58	0.5359
8.58	0.4826
16.95	0.4358
24.65	0.3985
32.45	0.3654
40.47	0.3360
48.06	0.3114
56.14	0.2876
64.16	0.2664
72.59	0.2469

$C_6H_{14}O$ —(Cont'd)	
$t, ^\circ C$	100η
81.47	0.2284
88.01	0.2154
A = 104.068	
B = 148.362	
$n = 1.9734$	

$C_6H_{14}O$ (39)	
Isopropyl ether	
20	0.322

$C_6H_{15}N$ (34)	
Triethylamine	
-33.5	0.7726
(72)	
25	0.363

$C_7H_5Cl_3$ (21)	
Benzotrichloride	
10	3.07
17	2.05

C_7H_5N (18)	
Benzonitrile	
25	1.25

C_7H_5N (9)	
Phenyl isocyanide	
0.28	1.957
10	1.615
20	1.330
30	1.133
40	0.983
50	0.863
60	0.767
70	0.687
80	0.622
100	0.514

C_7H_5NS (59)	
Phenyl thiocyanate	
25	1.4
35	1.2
50	0.98

C_7H_6O (18)	
Benzaldehyde	
25	1.40

$C_7H_6O_2$ (86)	
Salicylaldehyde	
45	1.798

$C_7H_6O_2$ (26)	
Benzoic acid	
122.5	1.67
130	1.26

C_7H_7NO (27)	
Formanilide	
120	1.65
(65)	
55	8.70

C_7H_8 (46)	
Toluene	
20.6	0.583
78.2	0.323
100	0.272

C_7H_8 (50)	
C_7H_8 (60)	
25	0.5520
25	0.5512

C_7H_8 —(Cont'd)	
$t, ^\circ C$	100η
(91)	
0.26	0.7655
9.88	0.6683
19.47	0.5900
30.25	0.5184
39.86	0.4667
49.43	0.4219
60.18	0.3799
69.13	0.3503
80.59	0.3164
91.74	0.2877
99.95	0.2695
107.08	0.2554

A = 18.954	
B = 112.99	
$n = 1.6522$	

C_7H_8O (39)	
Benzyl alcohol	
20	5.582
(83)	
25	5.054
30	4.326
35	3.739
40	3.288
45	2.906
50	2.574

C_7H_8O (14.5)	
<i>o</i> -Cresol	
0	39.7
10	17.9
20	9.56
30	6.12
40	4.10
60	2.24
80	1.43
110	0.89

C_7H_8O (14.5)	
<i>m</i> -Cresol	
0	84.4
10	34.6
20	16.9
30	9.47
40	5.92
60	2.99
80	1.80
110	1.02

C_7H_8O (14.5)	
<i>p</i> -Cresol	
0	98.4
10	39.6
20	18.9
30	10.5
40	6.54
60	3.28
80	1.93
110	1.08

C_7H_8O (5)	
Phenyl methyl ether	
25	1.01

C_7H_9N (72)	
Benzylamine	
25	1.59
130	0.442

C_7H_9N (32)	
2, 6-Lutidine	
25	0.881

C_7H_9N (9); cf. (59, 72, 87)	
Methylaniline	
0.3	4.265
10	3.065
20	2.303
30	1.811
40	1.466
50	1.215
70	0.886

C_7H_9N (9); cf. (72, 87)	
<i>o</i> -Toluidine	
0.31	10.105
10	6.428
20	4.392
30	3.194
40	2.436
50	1.919
60	1.578
70	1.302
80	1.109
90	0.952
100	0.831

C_7H_9N (72)	
<i>m</i> -Toluidine	
25	3.31
130	0.50
(87)	
55	1.51

C_7H_9N (87)	
<i>p</i> -Toluidine	
55	1.56
(72)	
130	0.52
(14)	

39.9	2.08
59.9	1.39
79.8	1.01
99.9	0.776
125	0.608
150	0.491
175	0.423

C ₇ H ₁₂ O (42.5)	
<i>p</i> -Methylcyclohexanone	
<i>t</i> , °C	100 η
17.3	1.83
39.1	1.23
65.9	0.87
90	0.69

C ₇ H ₁₂ O (75)	
Methylcyclohexanone	
20	1.76

C ₇ H ₁₂ O (88)	
Suberone	
25	2.59

C ₇ H ₁₂ O ₂ (88)	
Ethyl cyclobutanecarboxylate	
25	0.996

C ₇ H ₁₂ O ₂ (88)	
Hexahydrobenzoic acid	
50	8.38

C ₇ H ₁₂ O ₄ (26)	
Diethyl malonate	
25	1.88

C ₇ H ₁₄ (16)	
Methylcyclohexane	
0	0.976
15	0.780
30	0.627

C ₇ H ₁₄ O (39)	
Diethylacetone	
20	0.6989

C ₇ H ₁₄ O (42.5)	
<i>o</i> -Hexahydrocresol	
39.1	6.97
65.9	2.56
90	1.26
(99)	
20	21.8

C ₇ H ₁₄ O (99)	
<i>m</i> -Hexahydrocresol	
20	23.0

C ₇ H ₁₄ O (99)	
<i>p</i> -Hexahydrocresol	
20	30.7

C ₇ H ₁₄ O (88)	
Dipropyl ketone	
25	0.685

C ₇ H ₁₄ O (39)	
Methylpropylacetone	
20	0.8398

C ₇ H ₁₄ O (87)	
Methyl <i>n</i> -amyl ketone	
25	0.766

C ₇ H ₁₄ O ₂ (87)	
α -Ethylvaleric acid	
25	3.80
50	2.06

C ₇ H ₁₄ O ₂ (39)	
Heptylic acid	
<i>t</i> , °C	100 η
20	4.357
(24)	
17.5	4.60
20	4.33
25	3.80
50	2.30
70	1.61
90	1.19

C ₇ H ₁₄ O ₂ (53)	
<i>n</i> -Amyl acetate	
11	1.58
(6)	
25	0.811

C ₇ H ₁₄ O ₂ (39)	
Ethyl <i>n</i> -valerate	
20	0.8362
(31)	
25	0.76
50	0.536

C ₇ H ₁₄ O ₂ (87)	
Ethyl α -methylbutyrate	
25	0.675

C ₇ H ₁₄ O ₂ (31)	
Isobutyl propionate	
25	0.67

C ₇ H ₁₄ O ₂ (39)	
Propyl <i>n</i> -butyrate	
20	0.8296

C ₇ H ₁₄ O ₂ (39)	
Propyl isobutyrate	
20	0.7389

C ₇ H ₁₆ (91)	
<i>n</i> -Heptane	
6.43	0.4797
6.56	0.4795
13.45	0.4418
21.74	0.4027
30.27	0.3685
38.34	0.3397
47.25	0.3112
55.03	0.2890
62.04	0.2714
70.09	0.2526
77.70	0.2372
85.49	0.2218
92.21	0.2096
A = 445.97	
B = 180.14	
<i>n</i> = 2.1879	
(60)	
25	0.3855

C ₇ H ₁₆ (91)	
2-Methylhexane	
0.42	0.4743
7.70	0.4343
15.88	0.3959
24.63	0.3607
32.31	0.3333
40.05	0.3092
49.01	0.2839

C ₇ H ₁₆ —(Cont'd)	
<i>t</i> , °C	100 η
56.46	0.2651
63.92	0.2484
71.84	0.2316
80.66	0.2149
88.41	0.2012
A = 362.79	
B = 180.47	
<i>n</i> = 2.1633	

C ₇ H ₁₆ O (39)	
<i>n</i> -Heptyl alcohol	
20	7.009
(31)	
25	5.68
50	2.68
90	1.00

C ₇ H ₁₆ O (30)	
<i>n</i> -Propylisopropyl carbinol	
25	4.76

C ₇ H ₁₆ O (30)	
Methylamyl carbinol	
25	5.08

C ₈ H ₈ (48)	
Phenylacetylene	
25	0.886

C ₈ H ₇ N (26)	
Benzyl cyanide	
25	1.98

C ₈ H ₈ (48)	
Styrene	
25	1.11

C ₈ H ₈ O (14.6)	
Acetophenone	
16	1.99
25	1.67
(57)	
25	1.67
50	1.24
95	0.653
(74.5)	
25	1.67
(49)	
25	1.681

C ₈ H ₈ O ₂ (18)	
Methoxybenzaldehyde	
25	4.22

C ₈ H ₈ O ₂ (26)	
Phenylacetic acid	
77	3.54
130	1.40

C ₈ H ₈ O ₂ (39)	
Methyl benzoate	
20	2.067

C ₈ H ₈ O ₂ (86)	
Phenyl acetate	
45	1.832

C ₈ H ₉ Cl (26)	
β -Chloroethylbenzene	
<i>t</i> , °C	100 η
25	1.92

C ₈ H ₉ NO (65)	
Form- <i>o</i> -toluide	
55	12.91

C ₈ H ₉ NO (27)	
Acetanilide	
120	2.22
(72)	
130	1.90

C ₈ H ₁₀ (91)	
Ethylbenzene	
0.41	0.869
11.41	0.744
21.66	0.654
32.90	0.572
47.11	0.491
60.51	0.430
73.81	0.381
83.62	0.349
95.60	0.316
107.97	0.287
119.19	0.263
131.40	0.241
A = 41.215	
B = 121.68	
<i>n</i> = 1.7616	
(26)	
25	0.632

C ₈ H ₁₀ (91), <i>o</i> -Xylene	
0.49	1.095
13.88	0.881
26.54	0.738
39.33	0.628
51.94	0.544
65.41	0.473
78.78	0.416
90.82	0.373
101.78	0.340
116.61	0.302
128.15	0.276
141.14	0.252
A = 19.644	
B = 96.352	
<i>n</i> = 1.6386	

C ₈ H ₁₀ (91), <i>m</i> -Xylene	
0.24	0.799
11.52	0.684
23.36	0.595
35.97	0.513
48.71	0.450
59.94	0.404
60.27	0.403
71.20	0.366
86.35	0.322
98.68	0.293
109.75	0.269
123.53	0.244
135.28	0.225
A = 19.395	
B = 115.66	
<i>n</i> = 1.6400	

C ₈ H ₁₀ (91)	
<i>p</i> -Xylene	
<i>t</i> , °C	100 η
8.28	0.752
20.53	0.639
31.23	0.561
41.85	0.498
53.59	0.441
64.87	0.396
77.27	0.353
88.87	0.320
100.84	0.290
111.83	0.267
123.26	0.245
135.21	0.225
A = 32.7453	
B = 117.730	
<i>n</i> = 1.7326	

C ₈ H ₁₀ O (26)	
2-Phenylethyl alcohol	
25	7.61
50	3.20

C ₈ H ₁₀ O (86)	
Benzyl methyl ether	
45	1.042

C ₈ H ₁₀ O (86)	
<i>o</i> -Cresyl methyl ether	
45	0.858

C ₈ H ₁₀ O (86)	
<i>m</i> -Cresyl methyl ether	
45	0.885

C ₈ H ₁₀ O (86)	
<i>p</i> -Cresyl methyl ether	
45	0.814

C ₈ H ₁₀ O (39)	
Phenetole	
20	1.261
(51)	
25	1.158
(86)	
45	0.833
(14)	

C ₈ H ₁₁ N (9)	
Dimethylaniline	
10	1.688
20	1.413
30	1.201
40	1.036
50	0.905
60	0.800
70	0.714

C ₈ H ₁₁ N—(Cont'd)	
<i>t</i> , °C	100 η
80	0.642
90	0.579
98	0.537
(14)	
0	2.025
10	1.654
20	1.387
30	1.17
40	1.024
60	0.798
80	0.658
126	0.461
177	0.341

C ₈ H ₁₁ N (9); cf. (72, 87)	
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N-Ethylaniline	
0.27	4.123
10	2.979
20	2.251
40	1.434
60	1.013
80	0.766
90	0.674
100	0.603

C ₈ H ₁₁ N (72)	
α -Phenylethylamine	
25	1.66

C ₈ H ₁₁ N (72)	
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$C_8H_{14}O_3$ (88) Ethyl dimethyl- acetoacetate $t, ^\circ C$ 100 η 25 1.60	$C_8H_{18}O$ (39) <i>n</i> -Octyl alcohol $t, ^\circ C$ 100 η 20 8.925 (31) 25 7.21 50 3.22 90 1.21	$C_9H_{10}O_2$ (26) β -Phenylpropionic acid $t, ^\circ C$ 100 η 49.7 9.8 130 1.72	$C_9H_{13}N$ (88) Dimethyl- <i>p</i> - toluidine $t, ^\circ C$ 100 η 55 0.86	$C_9H_{16}O_4$ (88) Diethyl dimethyl- malonate $t, ^\circ C$ 100 η 25 1.95	$C_9H_{20}O$ (30) Methylheptyl carbinol $t, ^\circ C$ 100 η 25 8.31
$C_8H_{14}O_4$ (26) Diethyl succinate 25 2.41	$C_8H_{18}O$ (87) <i>d</i> -sec.-Octyl alcohol 25 6.33	$C_9H_{10}O_3$ (86) Ethyl salicylate 45 1.803	$C_9H_{13}N$ (72) Ethyl- <i>o</i> -toluidine 25 1.98 (88) 25 2.00 55 1.10	$C_9H_{16}O_4$ (26) Diethyl glutarate 25 2.49	$C_{10}H_8$ (57) Naphthalene 80 0.886 90 0.759 (55) 150 0.217 152 0.196
C_8H_{16} (16) <i>o</i> -Dimethylcyclo- hexane	$C_8H_{18}O$ (87) <i>l</i> -sec.-Octyl alcohol 25 6.55	$C_9H_{10}OS$ (76) Ethyl thiobenzoate 25 2.42	$C_9H_{13}N$ (88) Ethyl- <i>p</i> -toluidine 25 2.40 55 1.21	$C_9H_{18}O$ (39) Dipropylacetone 20 1.282	$C_{10}H_9N$ (90) α -Naphthylamine 50 11.2 (72) 130 1.44
C_8H_{16} (16) <i>m</i> -Dimethylcyclo- hexane	$C_8H_{18}O$ (87) <i>dl</i> -sec.-Octyl alcohol 25 6.49	$C_9H_{10}S_2$ (76) Ethyl dithiobenzoate 25 3.12	$C_9H_{13}N$ (88) Methylethylaniline 55 0.97	$C_9H_{18}O_2$ (31) Isobutyl <i>n</i> -valerate 25 1.01	$C_{10}H_9N$ (72) β -Naphthylamine 130 1.34
C_8H_{16} (16) <i>p</i> -Dimethylcyclo- hexane	$C_8H_{18}O$ (29) Isopropylbutyl carbinol 25 7.12	$C_9H_{11}Cl$ (26) γ -Chloropropyl- benzene 25 2.47	$C_9H_{13}N$ (88) <i>n</i> -Propylaniline 25 2.53	$C_9H_{18}O_2$ (88) Ethyl α -ethylvaler- ate 25 0.905	$C_{10}H_{10}O_2$ (25) Safrol 25 2.30
$C_8H_{16}O$ (39) Ethylpropylacetone 20 0.8482	$C_8H_{18}O$ (39) Isobutyl ether 20 0.7491	$C_9H_{11}N$ (87) Allylaniline 55 1.41 (72) 130 0.506	$C_9H_{13}N$ (26) 3-Phenylpropyl- amine 25 3.6 (72) 25 3.9	$C_9H_{18}O_2$ (39) Propyl methyl- propylacetate 20 1.128	$C_{10}H_{10}O_2$ (25) Isosafrol 25 4.00
$C_8H_{16}O_2$ (39) <i>n</i> -Caprylic acid 20 5.7482 (31) 50 2.62 70 1.84 90 1.30	$C_8H_{18}O$ (31) Ethyl hexyl ether 25 0.929 50 0.653	$C_9H_{11}NO$ (27) <i>N</i> -Methyl- acetanilide 120 0.82	$C_9H_{14}O$ (25) Phorone 25 1.40	$C_9H_{18}O_2$ (39) Propyl diethylace- tate 20 1.182	$C_{10}H_{12}$ (88) Tetrahydronaphtha- lene 25 2.14 (45) 25 2.00 50 1.30 75 0.906
$C_8H_{16}O_2$ (39) Dipropylacetic acid 20 7.642	$C_8H_{18}O$ (39) Ethyl hexyl ether 25 0.929 50 0.653	$C_9H_{11}NO$ (65) Ethylformanilide 55 2.42	$C_9H_{14}O_4$ (86.5) Diethyl citraconate 24.7 3.25	$C_9H_{18}O_2$ (39) Ethyl ethylpropyl- acetate 20 0.994	$C_{10}H_{12}O_2$ (48) Eugenol 25 6.96
$C_8H_{16}O_2$ (31) Hexan- β -ol acetate 25 0.944	$C_8H_{18}O$ (31) Ethyl hexyl ether 25 0.929 50 0.653	$C_9H_{11}NO_2$ (87) Ethyl anthranilate 55 3.26	$C_9H_{14}O_4$ (88) Diethyl cyclopro- pane 1, 1-dicarboxy- late 25 2.36	$C_9H_{18}O_2$ (39) Methyl dipropyl- acetate 20 1.204	$C_{10}H_{12}O_2$ (48) Isoeugenol 25 2.68
$C_8H_{16}O_2$ (31) Isobutyl <i>n</i> -butyrate 25 0.84	$C_8H_{18}O$ (31) Ethyl hexyl ether 25 0.929 50 0.653	$C_9H_{11}NO_2$ (65) Phenylurethane 55 85.35	$C_9H_{16}O_2$ (88) Ethyl cyclohexane- carboxylate 25 1.79	$C_9H_{18}O_2$ (31) Hexan- β -ol propion- ate 25 1.04	$C_{10}H_{12}O_2$ (26) Ethyl phenylacetate 25 2.39
$C_8H_{16}O_2$ (39) <i>n</i> -Propyl <i>n</i> -valerate 20 1.038	$C_8H_{18}O$ (39) Isobutyl ether 20 0.7491	C_9H_{12} (26) <i>n</i> -Propylbenzene 25 0.793	$C_9H_{16}O_3$ (39) Methyl diethyl- acetoacetate 20 4.108	$C_9H_{18}O_2$ (39) Methyl octoate 25 1.26 50 0.846	$C_{10}H_{12}O_3$ (87) Ethyl mandelate 25 19.7
$C_8H_{16}O_2$ (39) Propyl methyl- ethylacetate 20 0.8479	$C_8H_{18}O$ (39) Isobutyl ether 20 0.7491	$C_9H_{12}O$ (26) β -Phenylpropyl alcohol 25 15.6 50 52.3	$C_9H_{16}O_3$ (39) Methyl diethyl- acetoacetate 20 4.108	$C_9H_{18}O_2$ (31) Heptan- β -ol acetate 25 1.17	$C_{10}H_{13}N$ (87) Methylallylaniline 55 1.068
C_8H_{18} (91) <i>n</i> -Octane 0.25 0.700 12.18 0.594 22.92 0.520 32.96 0.463 43.89 0.411 54.73 0.367 66.46 0.328 77.82 0.296 88.33 0.269 98.52 0.247 109.07 0.227 122.07 0.204 A = 171.82 B = 145.50 n = 2.029	$C_8H_{18}O$ (39) Isobutyl ether 20 0.7491	$C_9H_{12}O$ (39) Ethyl <i>p</i> -cresyl ether 20 1.467	$C_9H_{16}O_3$ (39) Methyl methyl- propylacetoacetate 20 2.826	$C_9H_{18}O_2$ (39) Pelargonic acid 20 8.333 (24) 20 8.08 25 7.00 50 3.79 70 2.41 90 1.73	$C_{10}H_{13}NO_2$ (65) Methylphenyl- urethane 55 2.55

$C_{10}H_{14}$ (88) <i>o</i> -Cymene	$C_{10}H_{14}$ (88) <i>n</i> -Butylbenzene	$C_{10}H_{14}O$ (88) <i>d</i> -Carvol	$C_{10}H_{14}O$ (39) Propyl <i>o</i> -tolyl ether	$C_{10}H_{15}N$ (9) Diethylaniline	$C_{10}H_{16}O_4$ (88) Diethyleyclobutane-1, 1-dicarboxylate	$C_{10}H_{18}$ (45) Decahydro-naphthalene	$C_{10}H_{15}O$ (88) Menthone	$C_{10}H_{18}O_3$ (39) Methyl ethylpropyl-acetoacetate	$C_{10}H_{18}O_3$ (39) Ethyl methylpropyl-acetoacetate	$C_{10}H_{18}O_3$ (39) Ethyl diethylacetoacetate	$C_{10}H_{18}O_4$ (88) Diethyl methyl-ethylmalonate	$C_{10}H_{18}O_4$ (26) Diethyl adipate	$C_{10}H_{20}O$ (47) Menthol	$C_{10}H_{16}O$ (87) Thymyl methyl ether	$C_{11}H_{17}N$ (87) Isoamylaniline	$C_{12}H_{13}N$ (87) Dimethyl- α -naphthylamine	$C_{12}H_{26}O$ (30) Octylisopropyl carbinol	$C_{14}H_{12}O_2$ —(Cont'd)
$t, ^\circ C$ 100 η	25 1.02	25 3.39	20 2.014(?)	0.5 3.841 10 2.850 20 2.185 40 1.425 60 1.021 80 0.777 98 0.630	25 2.61	25 2.41 50 1.58 75 1.08	25 2.31	20 4.869	20 2.720	25 2.47	25 2.78	34.9 25.05 37.8 20.36 43.4 13.68 56.9 6.89	$t, ^\circ C$ 100 η	$t, ^\circ C$ 100 η	$t, ^\circ C$ 100 η	$t, ^\circ C$ 100 η	$t, ^\circ C$ 100 η	
55.6 6.28 74.6 2.47 82.2 1.85 99 1.04	$C_{10}H_{20}O_2$ (31) Butan- β -ol <i>n</i> -hexoate	$C_{10}H_{20}O_2$ (39) Ethyl dipropyl-acetate	$C_{10}H_{20}O_2$ (31) Ethyl <i>n</i> -caprylate	$C_{10}H_{20}O_2$ (31) Hexan- β -ol <i>n</i> -butyrate	$C_{10}H_{20}O_2$ (31) Heptan- β -ol propionate	$C_{10}H_{20}O_2$ (31) Octan- β -ol acetate	$C_{10}H_{22}$ (7) <i>n</i> -Decane	$C_{10}H_{22}$ (13) 2, 7-Dimethyloctane	$C_{10}H_{22}O$ (30) Methyl- <i>n</i> -octyl carbinol	$C_{10}H_{22}O$ (30) Isopropyl- <i>n</i> -hexyl carbinol	$C_{11}H_{14}O_2$ (26) Ethyl β -phenyl-propionate	$C_{11}H_{16}NO$ (6) Acetoethyl- <i>o</i> -toluidine	$C_{11}H_{16}NO_2$ (65) Ethylphenyl-urethane	55 1.72 $C_{11}H_{20}$ (97) Nonylacetylene 25 2.00 $C_{11}H_{20}O_4$ (26) Diethyl <i>n</i> -pinelate 25 3.29 $C_{11}H_{22}O_2$ (26) Undecylic acid 50 7.30 $C_{11}H_{22}O_2$ (31) Hexan- β -ol <i>n</i> -valerate 25 1.56 $C_{11}H_{22}O_2$ (31) Heptan- β -ol <i>n</i> -butyrate (31) 25 1.57 $C_{11}H_{22}O_2$ (31) Octan- β -ol propionate 25 1.59 $C_{11}H_{22}O_2$ (31) Ethyl pelargonate 25 1.69 50 1.11 $C_{11}H_{22}O_2$ (31) Isobutyl <i>n</i> -heptoate 25 1.52 $C_{11}H_{22}O_2$ (39) Propyl dipropyl-acetate 20 1.791 $C_{11}H_{22}O_2$ (39) Ethyl diethylpropyl-acetate 20 3.861 $C_{11}H_{24}$ (7) <i>n</i> -Undecane 22.7 0.94 $C_{11}H_{24}O$ (30) Methylnonyl carbinol 25 12.3 $C_{12}H_{10}O$ (51) Diphenyl ether 25 3.864 (79) 25 3.66 $C_{12}H_{11}N$ (87) Diphenylamine 55 4.66 (14) 61 4.18 81 2.53 (72) 130 1.04	55 3.25 (72) 130 0.87 $C_{12}H_{13}N$ (87) Dimethyl- β -naphthylamine 55 3.36 (72) 130 0.95 $C_{12}H_{14}O_4$ (6) Diethyl phthalate 25 10.1 (65) 55 4.182 $C_{12}H_{16}O_2$ (39) Propyl hydrocinamate 20 3.9377 $C_{12}H_{17}NO_2$ (6) Ethyl- <i>o</i> -tolyl-urethane 25 9.44 $C_{12}H_{18}O$ (39) Thymyl ethyl ether 20 2.513(?) $C_{12}H_{18}O_6$ (97) Triethyl aconitate 25 11.7 $C_{12}H_{22}O_3$ (39) Ethyl dipropyl-acetoacetate 20 4.829 $C_{12}H_{22}O_4$ (26) Diethyl suberate 25 4.05 $C_{12}H_{24}O_2$ (24) Lauric acid 50 7.3 60 5.61 70 4.43 80 3.62 90 2.99 $C_{12}H_{24}O_2$ (31) Isobutyl <i>n</i> -octoate 25 1.82 $C_{12}H_{24}O_2$ (31) Hexan- β -ol <i>n</i> -hexoate 25 1.80 $C_{12}H_{24}O_2$ (31) Heptan- β -ol <i>n</i> -valerate 25 1.79 $C_{12}H_{24}O_2$ (31) Octan- β -ol <i>n</i> -butyrate 25 1.89 $C_{12}H_{26}$ (7) <i>n</i> -Dodecane 23.3 1.15	25 14.4 $C_{13}H_{10}O$ (57) Benzophenone 25 13.6 95 1.74 (65) 55 4.67 $C_{13}H_{12}$ (57) Diphenylmethane 100 0.83 $C_{13}H_{13}N$ (87) Benzylaniline 55 5.39 (72) 130 1.20 $C_{13}H_{13}N$ (14) <i>N</i> -Methyldiphenylamine 9.8 11.0 20.1 7.25 30 5.15 40 3.85 60 2.49 80 1.74 (72) 130 0.81 $C_{13}H_{20}O$ (39) Thymyl propylether 20 3.527 $C_{13}H_{26}O_2$ (31) Methyl laurate 25 3.08 50 1.85 $C_{13}H_{26}O_2$ (31) Isobutyl <i>n</i> -nonate 25 2.18 $C_{13}H_{26}O_2$ (31) Hexan- β -ol <i>n</i> -heptoate 25 2.15 $C_{13}H_{26}O_2$ (31) Heptan- β -ol hexoate 25 2.19 $C_{13}H_{26}O_2$ (31) Undecan- β -ol acetate 25 2.81 $C_{13}H_{28}$ (7) <i>n</i> -Tridecane 23.3 1.52 $C_{14}H_{12}O_2$ (51) Benzyl benzoate 25 8.504 (11) 5 19.28 15 12.12 25 8.292	40 5.243 60 3.259 80 2.245 90 1.912 100 1.655 (50) 25 8.454 $C_{14}H_{16}N$ (72) Dibenzylamine 25 6.16 130 0.812 $C_{14}H_{26}O_4$ (26) Diethyl sebacate 25 5.1 (97) 25 5.42 $C_{14}H_{28}O_2$ (24) Myristic acid 60 7.43 70 5.83 80 4.64 90 3.81 (31) 70 6.76 90 4.16 $C_{14}H_{28}O_2$ (31) Ethyl laurate 25 3.08 50 1.74 $C_{14}H_{28}O_2$ (31) Heptan- β -ol <i>n</i> -heptoate 25 2.56 $C_{14}H_{28}O_2$ (31) Octan- β -ol <i>n</i> -hexoate 25 2.55 $C_{14}H_{28}O_2$ (31) Undecan- β -ol propionate 25 2.84 $C_{14}H_{30}$ (7) <i>n</i> -Tetradecane 21.9 2.22 $C_{15}H_{17}N$ (87) Ethylbenzylaniline 55 4.77 $C_{15}H_{30}O_2$ (31) Isobutyl <i>n</i> -undecate 25 3.25 $C_{15}H_{30}O_2$ (31) Hexan- β -ol <i>n</i> -nonate 25 3.08 $C_{15}H_{30}O_2$ (31) Heptan- β -ol <i>n</i> -octoate 25 3.03 $C_{15}H_{30}O_2$ (31) Octan- β -ol <i>n</i> -heptoate 25 3.07	

$C_{16}H_{30}O_2$ (31) Undecan- β -ol <i>n</i> -butyrate	
<i>t</i> , °C	100 η
25	3.62

$C_{15}H_{32}$ (7) <i>n</i> -Pentadecane	
22	2.86

$C_{16}H_{17}NO_2$ (65) Benzylphenyl- urethane	
55	10.96

$C_{16}H_{27}N$ (87) Diisoamylaniline	
55	2.92

$C_{16}H_{32}O_2$ (24) Palmitic acid	
70	7.8
80	6.1
90	5.0
95	4.47

$C_{16}H_{32}O_2$ (31) Isobutyl laurate	
25	3.87

$C_{16}H_{32}O_2$ (31) Heptan- β -ol <i>n</i> -nonoate	
25	3.69

$C_{16}H_{32}O_2$ (31) Octan- β -ol <i>n</i> -octoate	
25	3.64

$C_{16}H_{32}O_2$ (31) Undecan- β -ol <i>n</i> -valerate	
25	3.74

$C_{16}H_{34}$ (7) <i>n</i> -Hexadecane	
22.2	3.63

$C_{16}H_{34}O$ (31) Cetyl alcohol	
50	14.6
90	3.53

$C_{17}H_{34}O_2$ (31) Hexan- β -ol undecoate	
25	4.3

$C_{17}H_{34}O_2$ (31) Octan- β -ol <i>n</i> -nonoate	
25	4.22

$C_{17}H_{34}O_2$ (31) Undecan- β -ol <i>n</i> -hexoate	
<i>t</i> , °C	100 η
25	4.14

$C_{18}H_{15}N$ (72) Triphenylamine	
130	6.4

$C_{18}H_{15}O_4P$ (65) Triphenyl phos- phate	
55	9.50

$C_{18}H_{15}P$ (97) Triphenylphosphine	
100	4.62

$C_{18}H_{15}Sb$ (97) Triphenylstibine	
70	9.34

$C_{18}H_{36}O_2$ (24) Stearic acid	
70	9.87
80	7.72
90	6.1
95	5.47
98	5.18

(31)	
70	9.4
90	5.6

$C_{18}H_{36}O_2$ (31) Ethyl palmitate	
25	5.76
50	3.14

$C_{18}H_{36}O_2$ (31) Isobutyl myristate	
25	5.32

$C_{18}H_{36}O_2$ (31) Hexan- β -ol laurate	
25	5.4

$C_{18}H_{36}O_2$ (31) Heptan- β -ol <i>n</i> -undecoate	
25	5.15

$C_{18}H_{36}O_2$ (31) Undecan- β -ol <i>n</i> -heptoate	
25	4.91

$C_{19}H_{16}$ (57) Triphenylmethane	
95	3.5
100	3.22

$C_{19}H_{38}O_2$ (31) Heptan- β -ol laurate	
<i>t</i> , °C	100 η
25	5.9

$C_{19}H_{38}O_2$ (31) Octan- β -ol undecoate	
25	5.82

$C_{20}H_{38}O_2$ (86.5) Ethyl elaidate	
24.7	8.17

$C_{20}H_{38}O_4$ (97) Diisoamyl sebacate	
25	12.0

$C_{20}H_{40}O_2$ (31) Ethyl stearate	
50	3.75

$C_{20}H_{40}O_2$ (31) Hexan- β -ol myristate	
25	6.73

$C_{20}H_{40}O_2$ (31) Octan- β -ol laurate	
25	6.87

$C_{20}H_{40}O_2$ (31) Undecan- β -ol nonoate	
25	6.61

$C_{21}H_{21}N$ (72) Tribenzylamine	
130	2.09

$C_{21}H_{42}O_2$ (31) Heptan- β -ol myristate	
25	7.75

$C_{22}H_{44}O_2$ (31) Octan- β -ol myristate	
25	8.91

$C_{22}H_{44}O_2$ (31) Undecan- β -ol undecoate	
25	8.73

$C_{23}H_{46}O_2$ (31) Undecan- β -ol laurate	
25	9.66

$C_{25}H_{50}O_2$ (31) Undecan- β -ol myristate	
25	12.3

INFLUENCE OF PRESSURE ON VISCOSITY (14.7)

η = viscosity of liquid under tabulated pressure and temperature.

η_{30° = viscosity of liquid at 30° and atmospheric pressure; poises.

P = pressure in kg/cm².

The reference value of η_{30° is indicated under the name of compound.

Values of $\log_{10} \frac{\eta}{\eta_{30^\circ}}$

CCl_4 , Carbon tetrachloride $\eta_{30^\circ} = 0.00845$		
<i>P</i> , kg/cm ²	30°	75°
1	0.000	9.760
500	0.190	9.949
1 000	0.351	0.100
4 000		0.542

CS_2 , Carbon disulfide $\eta_{30^\circ} = 0.00352$		
1	0.000	9.875
500	0.090	9.972
1 000	0.160	0.051
2 000	0.307	0.180
4 000	0.509	0.372
6 000	0.674	0.527
8 000	0.840	0.671
10 000	1.010	0.808
12 000	1.189	0.946

$CHCl_3$, Chloroform <i>v.</i> Vol. V, p. 11		
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CH_4O , Methyl alcohol <i>v.</i> Vol. V, p. 11		
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$C_2H_4Br_2$, Ethylene bromide $\eta_{30^\circ} = 0.0149$		
1	0.000	9.756
500	0.138	9.885
1 000		0.003
2 000		0.203

C_2H_5Br , Ethyl bromide $\eta_{30^\circ} = 0.00368$		
1	0.000	9.806
500	0.121	9.959
1 000	0.222	0.072
2 000	0.387	0.235
4 000	0.631	0.472
6 000	0.854	0.653
8 000	1.043	0.816
10 000	1.223	0.978
12 000	1.400	1.123

C_2H_5Cl , Ethyl chloride		
1	0.000	9.850
500	0.134	0.017
1 000	0.242	0.131
2 000	0.405	0.285
4 000	0.649	0.514
6 000	0.837	0.683
8 000	1.008	0.834
10 000	1.172	0.977
12 000	1.323	1.111

C_2H_5I , Ethyl iodide $\eta_{30^\circ} = 0.00540$		
<i>P</i> , kg/cm ²	30°	75°
1	0.000	9.837
500	0.115	9.954
1 000	0.218	0.057
2 000	0.385	0.227
4 000	0.656	0.467
6 000	0.888	0.672
8 000	1.108	0.854
10 000	1.330	1.030
12 000	1.549	1.200

C_2H_6O , Ethyl alcohol <i>v.</i> Vol. V, p. 11		
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C_3H_6O , Acetone $\eta_{30^\circ} = 0.00285$		
1	0.000	9.895
500	0.135	0.017
1 000	0.226	0.113
2 000	0.373	0.245
4 000	0.605	0.445
6 000	0.804	0.610
8 000	0.987	0.762
10 000	1.160	0.898
12 000		1.031

C_3H_8O , <i>n</i> -Propyl alcohol $\eta_{30^\circ} = 0.01779$		
1	0.000	9.598
500	0.151	9.754
1 000	0.283	9.880
2 000	0.494	0.074
4 000	0.836	0.368
6 000	1.131	0.610
8 000	1.402	0.827
10 000	1.667	1.033
12 000	1.915	1.223

C_3H_8O , Isopropyl alcohol $\eta_{30^\circ} = 0.01757$		
1	0.000	9.505
500	0.193	9.695
1 000	0.343	9.851
2 000	0.591	0.087
4 000	0.982	0.425
6 000	1.318	0.701
8 000	1.640	0.957
10 000	1.977	1.191
12 000	2.311	1.424

$C_2H_8O_3$, Glycerol		
$\eta_{30^\circ} = 3.8$		
P , kg/cm ²	30°	75°
1	0.000	8.810
500	0.134	8.920
1 000	0.260	9.023
2 000	0.497	9.204
4 000	0.936	9.529
6 000	1.346	9.818
8 000	1.741	0.094
10 000	2.133	0.369
12 000		0.628

$C_4H_8O_2$, Ethyl acetate		
$\eta_{30^\circ} = 0.0039$		
P , kg/cm ²	30°	75°
1	0.000	9.836
500	0.142	9.976
1 000	0.258	0.081
2 000	0.463	0.253
4 000	0.818	0.517
6 000	1.120	0.761
8 000	1.393	0.992
10 000	1.686	1.213
12 000	1.974	1.416

C_4H_9Br , <i>n</i> -Butyl bromide		
$\eta_{30^\circ} = 0.00537$		
P , kg/cm ²	30°	75°
1	0.000	9.832
500	0.143	9.975
1 000	0.269	0.090
2 000	0.474	0.273
4 000	0.816	0.564
6 000	1.115	0.811
8 000	1.408	1.040
10 000	1.715	1.264
12 000	2.018	1.484

$C_4H_{10}O$, <i>n</i> -Butyl alcohol		
$\eta_{30^\circ} = 0.02237$		
P , kg/cm ²	30°	75°
1	0.000	9.548
500	0.175	9.724
1 000	0.321	9.867
2 000	0.554	0.089
4 000	0.934	0.312
6 000	1.289	0.690
8 000	1.609	0.941
10 000	1.912	1.172
12 000	2.208	1.396

$C_4H_{10}O$, Isobutyl alcohol		
$\eta_{30^\circ} = 0.02864$		
P , kg/cm ²	30°	75°
1	0.000	9.444
500	0.210	9.659
1 000	0.388	9.824
2 000	0.696	0.075
4 000	1.203	0.488
6 000	1.655	0.838
8 000	2.075	1.158
10 000	2.483	1.459
12 000	2.898	1.747

$C_4H_{10}O$, Ethyl ether		
<i>v.</i> Vol. V, p. 11		

C_5H_{12} , Isopentane		
$\eta_{30^\circ} = 0.00198$		
P , kg/cm ²	30°	75°
1	0.000	9.821
500	0.202	0.040
1 000	0.344	0.193

C_5H_{12} —(Continued)		
P , kg/cm ²	30°	75°
2 000	0.559	0.408
4 000	0.894	0.715
6 000	1.175	0.960
8 000	1.431	1.179
10 000	1.687	1.381
12 000	1.947	1.586

C_5H_{12} , <i>n</i> -Pentane		
$\eta_{30^\circ} = 0.00220$		
P , kg/cm ²	30°	75°
1	0.000	9.811
500	0.181	0.014
1 000	0.315	0.163
2 000	0.524	0.380
4 000	0.847	0.676
6 000	1.112	0.908
8 000	1.360	1.119
10 000	1.615	1.313
12 000	1.846	1.493

$C_5H_{12}O$, Isoamyl alcohol		
P , kg/cm ²	30°	75°
1	0.000	9.424
500	0.209	9.618
1 000	0.386	9.787
2 000	0.686	0.065
4 000	1.185	0.492
6 000	1.636	0.848
8 000	2.069	1.168
10 000	2.505	1.483
12 000	2.952	1.780

$C_5H_{12}O$, <i>n</i> -Amyl alcohol		
P , kg/cm ²	30°	75°
1	0.000	9.540
500	0.188	9.723
1 000	0.341	9.871
2 000	0.607	0.105
4 000	1.060	0.466
6 000	1.448	0.772
8 000	1.811	1.049
10 000	2.164	1.313
12 000	2.495	1.562

C_6H_5Br , Bromobenzene		
$\eta_{30^\circ} = 0.00985$		
P , kg/cm ²	30°	75°
1	0.000	9.801
500	0.138	9.930
1 000	0.262	0.044
2 000	0.486	0.228
4 000	0.897	0.558
6 000		0.874

C_6H_5Cl , Chlorobenzene		
$\eta_{30^\circ} = 0.00711$		
P , kg/cm ²	30°	75°
1	0.000	9.814
500	0.133	9.936
1 000	0.253	0.053
2 000	0.478	0.245
4 000	0.867	0.563
6 000	1.223	0.852
8 000		1.146
10 000		1.465

$C_6H_5NO_2$, Nitrobenzene		
P , kg/cm ²	30°	75°
1	0.000	
500	0.134	
1 000	0.264	

C_6H_6 , Benzene		
<i>v.</i> Vol. V, p. 12		

C_6H_{12} , Cyclohexane		
$\eta_{30^\circ} = 0.00828$		
P , kg/cm ²	30°	75°
1	0.000	9.723
500	0.261	9.975
1 000		0.169

C_6H_7N , Aniline		
$\eta_{30^\circ} = 0.0319$		
P , kg/cm ²	30°	75°
1	0.000	9.551
500	0.195	9.703
1 000	0.376	9.847
2 000	0.709	0.102
4 000		0.560

C_6H_{14} , <i>n</i> -Hexane		
$\eta_{30^\circ} = 0.00296$		
P , kg/cm ²	30°	75°
1	0.000	9.803
500	0.184	0.028
1 000	0.332	0.171
2 000	0.561	0.379
4 000	0.914	0.701
6 000	1.224	0.961
8 000	1.514	1.198
10 000	1.803	1.426
12 000		1.646

C_7H_8 , Toluene		
$\eta_{30^\circ} = 0.00523$		
P , kg/cm ²	30°	75°
1	0.000	9.796
500	0.145	9.939
1 000	0.274	0.065
2 000	0.497	0.267
4 000	0.897	0.597
6 000	1.285	0.896
8 000	1.699	1.186
10 000	2.177	1.504
12 000		1.832

C_7H_{14} , Methylcyclohexane		
$\eta_{30^\circ} = 0.00639$		
P , kg/cm ²	30°	75°
1	0.000	9.747
500	0.220	9.976
1 000	0.388	0.154
2 000	0.710	0.434
4 000	1.274	0.900
6 000	1.804	1.335
8 000	2.318	1.756
10 000		2.167
12 000		2.582

C_8H_{10} , <i>o</i> -Xylene		
$\eta_{30^\circ} = 0.00709$		
P , kg/cm ²	30°	75°
1	0.000	9.767
500	0.165	9.925
1 000	0.311	0.057
2 000	0.577	0.292
4 000		0.689
6 000		1.087

C_8H_{10} , <i>m</i> -Xylene		
$\eta_{30^\circ} = 0.00552$		
P , kg/cm ²	30°	75°
1	0.000	9.799
500	0.154	9.959
1 000	0.290	0.079
2 000	0.529	0.286
4 000	0.967	0.637
6 000		0.983
8 000		1.333

C_8H_{10} , <i>p</i> -Xylene		
$\eta_{30^\circ} = 0.00568$		
P , kg/cm ²	30°	75°
1	0.000	9.797
500	0.152	9.957
1 000		0.092
2 000		0.315

C_8H_{18} , <i>n</i> -Octane		
$\eta_{30^\circ} = 0.00483$		
P , kg/cm ²	30°	75°
1	0.000	9.810
500	0.196	0.003
1 000	0.327	0.153
2 000	0.641	0.390
4 000	1.088	0.763
6 000	1.487	1.080
8 000		1.363
10 000		1.630

$C_{10}H_{12}O_2$, Eugenol		
P , kg/cm ²	30°	75°
1	0.000	9.429
500	0.288	9.616
1 000	0.541	9.810
2 000	1.081	0.143
3 000	2.273	0.805
5 000		1.520
8 000		2.343

$C_{10}H_{14}$, <i>p</i> -Cymene		
P , kg/cm ²	30°	75°
1	0.000	9.800
500	0.172	9.948
1 000	0.333	0.087
2 000	0.626	0.335
4 000	1.194	0.749
6 000	1.859	1.168
8 000		1.612
10 000		2.164

$C_{10}H_{15}N$, Diethylaniline		
P , kg/cm ²	30°	75°
1	0.000	9.690
500	0.201	9.839
1 000	0.394	9.984
2 000	0.761	0.259
4 000		0.758
6 000		1.250
8 000		1.775

$C_{10}H_{18}O$, Cineole		
P , kg/cm ²	30°	75°
1	0.000	9.654
500	0.315	9.905
1 000		0.142
2 000		0.575

$C_{10}H_{22}O$, <i>n</i> -Amyl ether		
P , kg/cm ²	30°	75°
1	0.000	9.736
500	0.218	9.943
1 000	0.401	0.107
2 000	0.708	0.364
4 000	1.230	0.776
6 000	1.685	1.125
8 000	2.091	1.437
10 000		1.728
12 000		2.007

$C_{18}H_{34}O_2$, Oleic acid		
P , kg/cm ²	30°	75°
1	0.000	9.419
500	0.306	9.671
1 000	0.616	9.989
2 000		0.255
4 000		0.843

LITERATURE

(For a key to the periodicals see end of volume)

- (¹) Archibald and Ure, 4, 125: 726; 24. (²) Arndt, *Z. chem. Apparatenkunde*, 3: 549; 08. (³) Arndt and Ploetz, 7, 121: 439; 26. (⁴) Aten, 7, 66: 641; 09. (⁵) Baker, 4, 101: 1049; 12. (⁶) Baker, 4, 103: 1653; 13. (⁷) Bartoli and Stracciati, 59, 8: 195; 85. 6, 7: 375; 86. (⁸) Beck, 7, 58: 425; 07. (⁹) Bingham, VanKlooster and Kleinspehn, 50, 24: 1; 20.
- (¹⁰) Bingham, Schlesinger and Coleman, 1, 38: 27; 16. (¹¹) Bingham and Sarver, 1, 42: 2011; 20. (¹²) Bingham and White, 1, 33: 1257; 11. (¹³) Bingham, White, Thomas and Cadwell, 7, 83: 641; 13. (¹⁴) Bramley, 4, 109: 10; 16. (^{14.5}) Bramley, 4, 109: 434; 16. (^{14.6}) Bregemann, *Thesis*, Lausanne, 1914. (^{14.7}) Bridgman, 65, 61: 55; 26. (¹⁵) Briner and Pytkoff, 42, 10: 640; 12. (¹⁶) Chavanne and van Resseghe, 28, 31: 87; 22. (¹⁷) Cohen and Bruins, 7, 103: 404; 23. (¹⁸) Creighton, 143, 189: 641; 20. (¹⁹) Drapier, 28, 1911; 621.
- (²⁰) Drucker and Kassel, 7, 76: 367; 11. (²¹) Dummer, *Diss.*, Freiburg, 1909. (²²) Dunstan, 7, 49: 590; 04. (²³) Dunstan, 7, 51: 732; 05. (²⁴) Dunstan, 4, 107: 667; 15. (²⁵) Dunstan and Hilditch, 9, 18: 185; 12. (²⁶) Dunstan, Hilditch and Thole, 4, 103: 133; 13. (²⁷) Dunstan and Mussel, 4, 97: 1935; 10. (²⁸) Dunstan and Mussel, 4, 99: 565; 11. (²⁹) Dunstan and Thole, 4, 95: 1556; 09.
- (³⁰) Dunstan and Thole, 4, 103: 127; 13. (³¹) Dunstan, Thole and Benson, 4, 105: 782; 14. (³²) Dunstan, Thole and Hunt, 4, 91: 1728; 07. (³³) Efremov, 53, 50: 340; 18. 10, 5: 50; 25. (³⁴) Elsey, 1, 42: 2454; 20. (³⁵) English and Turner, 4, 105: 1656; 14. (³⁶) Erk, *Zähigkeitsmessungen an Flüssigkeiten*, Berlin, V. D. I. Verlag, 1927. (³⁷) Farr and McLeod, 5, 97: 80; 20. (³⁸) Fitzgerald, 50, 16: 621; 12. (³⁹) Gartenmeister, 7, 6: 524; 90.
- (⁴⁰) Goodwin and Mailey, 2, 26: 28; 08. (⁴¹) Hartley, Thomas and Applebey, 4, 93: 538; 08. (⁴²) Herz, 9, 23: 24; 17. (^{42.5}) Herz and Bloch, 7, 110: 23; 24. (⁴³) Herz and Martin, 93, 132: 41; 24. (⁴⁴) Herz and Rathmann, 93, 44: 589; 13. (⁴⁵) Herz and Schuftan, 7, 101: 269; 22. (⁴⁶) Heydweiller, 8, 59: 193; 96. (⁴⁷) Heydweiller, 8, 63: 56; 97. (⁴⁸) Hilditch and Dunstan, 9, 18: 881; 12. (⁴⁹) Kendall and Brakeley, 1, 43: 1826; 21.
- (⁵⁰) Kendall and Monroe, 1, 39: 1787; 17. (⁵¹) Kendall and Wright, 1, 42: 1776; 20. (⁵²) Kernot and Pomilio, 71, 17: 359; 11. (⁵³) Kremann, Gugl and Meingast, 57, 35: 1365; 14. (⁵⁴) Kuenen and Visser, 64P, 16: 355; 13. 168, No. 138a. (⁵⁵) Kurnakov, 93, 135: 81; 24. (⁵⁶) Kurnakov and Beketov, 134, 9: 1381; 15. 10, 4: 13; 21. (⁵⁷) Kurnakov, Krotkov and Oksmann, 53, 49: 583; 15. 10, 4: 13; 21. (^{57.5}) Kurnakov and Kviat, 169, 20: 664; 13. 53, 46: 138; 14. 7, 88: 411; 14. (⁵⁸) Kurnakov, Perel'muter and Kanov, 169, 24: 399; 15. 10, 4: 64; 21. (⁵⁹) Kurnakov and Zhemchuzhnyi, 7, 83: 481; 13.
- (⁶⁰) Lewis, 1, 47: 626; 25. (^{60.5}) Linebarger, 1, 17: 615, 690; 95. (⁶¹) Lorenz, 7, 79: 63; 12. (⁶²) Lorenz and Hoechberg, 93, 94: 317; 16. (⁶³) Lorenz and Kalmus, 7, 59: 244; 07. (⁶⁴) Maass and Boomer, 1, 44: 1709; 22. (⁶⁵) McBain, Harvey and Smith, 50, 30: 312; 26. (⁶⁶) Mathews and Faville, 50, 22: 1; 18. (⁶⁷) Menneret, 51, 1: 753; 11. (⁶⁸) Merry and Turner, 4, 105: 748; 14. (⁶⁹) Meyer and Mylius, 7, 95: 349; 20.
- (⁷⁰) Miller, 5, 106: 724; 24. (⁷¹) Muchin, 9, 19: 819; 13. (⁷²) Mussel, Thole and Dunstan, 4, 101: 1008; 12. (⁷³) Pagliani and Battelli, 23, 20: 449; 85. (⁷⁴) Philip and Oakley, 4, 125: 1189; 24. (^{74.5}) Polliack, *Thesis*, Lausanne, 1913. (⁷⁵) Rabe and Pollack, 25, 45: 2924; 12. (⁷⁶) Reid, 172(8th), 25: 423; 13. (⁷⁷) Sachanov, 7, 83: 129; 13. (⁷⁸) Sachanov and Rabinovich, 53, 47: 861; 15. 10, 4: 64; 21. (⁷⁹) Sachanov and Ryakhovskii, 53, 47: 128; 15. 10, 4: 64; 21.
- (⁸⁰) Scarpa, 59, 6: 277; 04. 42, 2: 447; 04. (⁸¹) Scheuer, 7, 72: 513; 10. (⁸²) Schlesinger and Coleman, 1, 38: 271; 16. (⁸³) Sorkau, 63, 15: 768; 14. (⁸⁴) Steacie and Johnson, 1, 47: 754; 25. (⁸⁵) Stückgold, 42, 15: 502; 17. (⁸⁶) Thole, 4, 97: 2596; 10. (^{86.5}) Thole, 4, 101: 552; 12. (⁸⁷) Thole, 4, 103: 317; 13. (⁸⁸) Thole, 4, 105: 2004; 14. (⁸⁹) Thole, 7, 74: 683; 10.
- (⁹⁰) Thole, Mussel and Dunstan, 4, 103: 1108; 13. (⁹¹) Thorpe and Rodger, 62, 185: 397; 95. (⁹²) Thorpe and Rodger, 62, 189: 71; 97. (⁹³) Traube, 25, 19: 871; 86. (⁹⁴) Verschaffelt, 64P, 20: 986; 18. 168, No. 153b. (⁹⁵) Verschaffelt, 64P, 18: 1659; 16. 168, No. 149b. (⁹⁶) Walden, 7, 55: 207; 06. (⁹⁷) Walden and Swinne, 7, 82: 271; 13. (⁹⁸) Warburg and von Babo, 8, 17: 390; 82. (⁹⁹) Weissenberger and Schuster, 57, 45: 413; 24.
- (¹⁰⁰) Weissenberger, Schuster and Mayer, 57, 45: 449; 24. (¹⁰¹) Wroczynski and Guye, 42, 8: 189; 10. (¹⁰²) Fredenhagen and Dahlmlos, 93, 179: 77; 29. (¹⁰³) Walden and Swinne, 7, 79: 717; 12.

FREE ENERGY OF CHEMICAL SUBSTANCES, ACTIVITY COEFFICIENTS, PARTIAL MOLAL QUANTITIES, AND RELATED CONSTANTS¹

MERLE RANDALL, SPECIAL EDITOR

Including

EQUILIBRIA BETWEEN TWO SOLID PHASES AND A GAS PHASE (DECOMPOSITION PRESSURES OF HYDRATES, AMMONIATES, ETC.)

FRITZ EPHRAIM²

and

SOLUBILITY OF SLIGHTLY SOLUBLE SALTS IN AQUEOUS SALT SOLUTIONS

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SCOPE OF THE SECTION

This section includes all chemical equilibria except those which have been treated in previous sections. The section also includes miscellaneous thermodynamic data, such as partial molal quantities, activity coefficients, heat capacities of substances, etc., when these are combined with other data.

The tables are not as complete as could be desired. An attempt has been made to include as many types of systems as possible, and more space has been given to those systems which have not been widely discussed in the literature than to the more common systems. Omission of a table or mention by reference only in no way reflects upon the quality or importance of the data.

OBJET TRAITÉ DANS LA SECTION

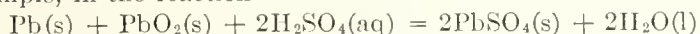
Cette section comprend tous les équilibres chimiques, à l'exception de ceux dont il a déjà été traité dans des sections précédentes. La section renferme aussi des données thermodynamiques diverses, telles que des quantités moléculaires partielles, coefficients d'activité, capacités calorifiques des substances, etc., lorsque celles-ci sont combinées à d'autres données.

Les tables ne sont pas aussi complètes qu'on puisse le désirer. On s'est efforcé d'y mentionner un nombre aussi grand que possible de types de systèmes, et il a été réservé plus d'espace aux systèmes qui n'ont pas été largement discutés dans la littérature qu'aux systèmes plus communs. L'omission d'une table ou sa mention par une référence seulement ne se rapporte en aucune manière à la qualité ou à l'importance de la donnée.

¹ See also Entropy, etc., Vol. V, p. 84.² Editorial Note.—The data on this topic, compiled by Professor Ephraim, have been combined with the other data of this section according to the Standard Arrangement. They are identified by the symbol (E). Translation from the German and conversion into the units °K and atm. were effected by Gerald F. Breckenridge under the direction of the Special Editor.³ The senior author is alone responsible for the data on the complex amines and for references subsequent to the year 1925. For this section, see p. 313.

ARRANGEMENT

1. The systems or reactions are listed in the standard arrangement (*see* Vol. III, p. viii) in accordance with that substance in the reaction which has the highest key-formula. Thus, for example, in the reaction



the key-formulae are:

Pb, 23; PbO₂, 23—12; H₂SO₄, 8—22—14; PbSO₄, 23—8—14; H₂O, 22—1.

The highest key-formula is that for PbSO₄, 23—8—14 and this reaction will therefore be found listed under PbSO₄ and can be found by turning the pages until 23 appears as the first member of the key-numbers which appear at the top of each right-hand page. After locating the proper section in this way, the desired system or reaction can then be located by inspection.

2. Where choice of condition or state is involved for a given substance the order is gas (g); liquid (l); solid (s); in aqueous solution (aq); in non-aqueous solution, standard arrangement by solvents.

3. *Important Exceptions*.—Solid hydrates, ammines, etc., containing water, ammonia, etc., "of crystallization" are listed under the parent material. Water, ammonia, etc., of crystallization should, therefore, be neglected in writing key-formulae. (These exceptions do not, however, apply to complex ions, complex cobaltammines, etc.) Solubility data are in all cases listed under the solute.

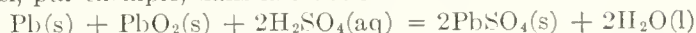
SYMBOLS AND ABBREVIATIONS

In general the notation of Lewis and Randall (⁸⁸⁵) is used.

<i>a</i>	Activity.
<i>c</i>	Concentration (moles per liter).
<i>c_±</i>	Geometrical mean of concentration of ions.
<i>f</i>	Fugacity.
het.	Two-phase system richest in solute.
ln	Logarithm to the base <i>e</i> .
log	Logarithm to the base 10.
<i>m</i>	Molality (moles per 1000 g H ₂ O, <i>in vacuo</i>).
<i>m_±</i> <i>m_±⁰</i>	<i>v.</i> p. 227.
<i>n</i>	Number of moles.
<i>p</i>	Vapor pressure (in atmospheres).
<i>p.f.</i>	Proportionality factor (<i>see</i> activity coefficients).
<i>s</i>	Solubility (moles per 1000 g H ₂ O, <i>in vacuo</i>).
<i>s_c</i>	Solubility (moles per liter).
<i>t</i>	Temperature, °C.
<i>x</i>	Mole fraction.
<i>C_p</i>	Molal heat capacity at constant pressure.
<i>C_v</i>	Molal heat capacity at constant volume.
<i>E</i>	Internal energy.
<i>E</i>	Electromotive force.
<i>E⁻</i>	One gram atom of negative electricity.
<i>F</i>	Free energy.
<i>H</i>	Heat content.
<i>I</i>	Integration constant.
<i>K</i>	Equilibrium constant (activities) <i>v.</i> p. 227.
<i>K'</i>	Special equilibrium function.
<i>K_c</i>	Equilibrium function in terms of concentration.
<i>K_m</i>	Equilibrium function in terms of molalities.
<i>K_p</i>	Equilibrium function in terms of partial pressures.
<i>l̄</i>	Relative partial molal heat content.
<i>M</i>	Molal.
<i>P</i>	Total pressure or vapor pressure, in atmospheres.
<i>R</i>	Gas constant.
<i>S</i>	Entropy.
<i>T</i>	Absolute temperature.
<i>V</i>	Volume.
<i>w</i>	Molal mass.

ARRANGEMENT

1. Les systèmes ou les réactions sont disposés en liste suivant l'arrangement type (*voir* Vol. III, p. viii) en accord avec la substance de la réaction qui possède la formule-clé la plus élevée. Ainsi, par exemple, dans la réaction



les formules-clés sont

Pb, 23; PbO₂, 23—12; H₂SO₄, 8—22—14; PbSO₄, 23—8—14; H₂O, 22—1.

La formule-clé la plus élevée est celle de PbSO₄, 23—8—14 et par conséquent on trouvera la réaction mentionnée ci-dessus sous PbSO₄; on tournera donc les pages jusqu'à ce qu'on atteigne 23, premier membre des nombres-clés inscrits au haut de chacune des pages se trouvant à main droite. Ayant trouvé de cette façon la section convenable, on y recherchera alors, le système de réaction désiré.

2. Lorsque le choix de la condition ou de l'état est impliqué pour une substance donnée, l'ordre est gaz (g); liquide (l); solide (s); en solution aqueuse (aq); en solution non-aqueuse, arrangement type par dissolvants.

3. *Exceptions Importantes*.—Les hydrates solides, les ammines, etc., contenant de l'eau, de l'ammoniaque, etc., "de cristallisation" sont inscrits en liste sous la matière principale. L'eau, l'ammoniaque, etc., de cristallisation doivent donc être négligés lorsqu'on écrit la formule-clé. (Ces exceptions cependant ne s'appliquent pas aux ions complexes, cobaltammines complexes, etc.) Les données de solubilité sont dans tous les cas inscrits sous le corps dissous.

SYMBOLES ET ABRÉVIATIONS

C'est en général la notation de Lewis et Randall (⁸⁸⁵) qui est utilisée.

<i>a</i>	Activité.
<i>c</i>	Concentration (mol gr. par litre).
<i>c_±</i>	Moyenne géométrique de la concentration des ions.
<i>f</i>	Fugacité.
het.	Système à deux phases le plus riche en corps dissous.
ln	Logarithme de base <i>e</i> .
log	Logarithme de base 10.
<i>m</i>	"Molalité" (mol gr. par 1000 g H ₂ O, dans le vide).
<i>m_±</i> <i>m_±⁰</i>	<i>v.</i> p. 227.
<i>n</i>	Nombre de molécules grammes.
<i>p</i>	Pression de vapeur (en atmosphères).
<i>p.f.</i>	Facteur de proportionnalité (<i>voir</i> coefficients d'activité).
<i>s</i>	Solubilité (molécules gr. par 1000 g H ₂ O, dans le vide).
<i>s_c</i>	Solubilité (molécules gr. par litre).
<i>t</i>	Température, °C.
<i>x</i>	Fraction moléculaire gramme.
<i>C_p</i>	Capacité calorifique moléculaire à pression constante.
<i>C_v</i>	Capacité calorifique moléculaire à volume constant.
<i>E</i>	Énergie interne.
<i>E</i>	Force électromotrice.
<i>E⁻</i>	Un atome gramme d'électricité négative.
<i>F</i>	Énergie libre.
<i>H</i>	Contenu de chaleur.
<i>I</i>	Constante d'intégration.
<i>K</i>	Constante d'équilibre (activités), <i>v.</i> p. 227.
<i>K'</i>	Fonction d'équilibre spéciale.
<i>K_c</i>	Fonction d'équilibre en termes de concentration.
<i>K_m</i>	Fonction d'équilibre en termes de molalité.
<i>K_p</i>	Fonction d'équilibre en termes de pressions partielles.
<i>l̄</i>	Contenu de chaleur relatif partiel moléculaire.
<i>M</i>	Moléculaire gramme.
<i>P</i>	Pression totale ou pression de vapeur, en atmosphères.
<i>R</i>	Constante des gaz.

γ	Activity coefficient.
μ	Ionic strength.
μ_c	Ionic strength (for concentrations).
ν	Number of ions formed by dissociation of one molecule.
Δ	Increment.
Small cap roman: molal quantities, thus μ .	
Small cap roman with bar: Partial molal quantity, thus $\bar{\mu}$.	
Subscript ₁ (resp. ₂) identifies solvent (resp. solute).	

UNITS AND VALUES OF CONSTANTS USED*

1 cal.	4.182 joules.
T	$t + 273.1$.
R	82.07 cm ³ -atm. per deg. K.
R	1.9885 cal. per deg. K.
V	(for 1 mole of a perfect gas) 22 412 cm ³ at 1 atm. and 273.1°K.
F	96 494 coulombs per equiv.
F	23 074 cal. per volt equiv.

All pressures are expressed in atmospheres, all temperatures in degrees absolute, all electromotive forces in volts and all energy quantities in calories (*v. supra*) unless otherwise expressly stated. When making further transformations of the data, it is important to use only the constants and data of this section.

FREE ENERGY DATA

In general, the accuracy of the free energy equations may be judged by the constancy of the quantity I where this has been tabulated. The lack of a definite trend with a variation in temperature indicates that the choice of the particular form of substances taking part in the reaction and the values of the ΔH and ΔC_p are probably substantially correct. The individual variations indicate the degree of precision of the experimental measurements. Since many of the derived values involve addition and subtraction of other equations, it is not possible, at this time, to give the probable error, and the number of significant figures given should not be interpreted as an indication of the accuracy. Where 'revised' values are indicated, it is usually necessary to use the unrevised (⁸⁸⁵) values, when these are to be combined with other equations in this section.

The free energies are given in the form

$$\Delta F^0 = \Delta H_0^0 - \Delta \Gamma_0^0 T \ln T - \frac{1}{2} \Delta \Gamma' T^2 - \frac{1}{6} \Delta \Gamma'' T^3 - \dots + IT \quad (1)$$

where $\Delta \Gamma$, $\Delta \Gamma'$ and $\Delta \Gamma''$, etc., are the coefficients in the algebraic expression for the increase in heat capacity of the reaction.

We thus have

$$\Delta H^0 = \Delta H_0^0 + \Delta \Gamma_0^0 T + \frac{1}{2} \Delta \Gamma' T^2 + \frac{1}{3} \Delta \Gamma'' T^3 \quad (2)$$

$$\Delta S^0 = \Delta \Gamma_0^0 (1 + \ln T) + \Delta \Gamma' T + \frac{1}{2} \Delta \Gamma'' T^2 + \dots - I \quad (3)$$

The superscript ⁰ on the quantities ΔF , ΔH , ΔS indicates that the quantity is that for a stated or implied reaction in which all chemical substances involved are assumed to be at unit activity, at a fugacity of 1 atm. (or, when specifically so stated, at a pressure of 1 atm.), or hypothetical unit concentration. Where the reaction is not explicitly stated it is assumed to be the reaction of formation of a stated substance out of its elements in their standard states. The standard state of an element is that state to which the value $\Delta F^0 = 0$ is assigned in the tables, the pressure being always one atm. unless otherwise specifically stated. When no standard state is thus indicated in the tables, the "ordinary" solid form of the element is assumed.

In writing the equilibrium constant, K , the activities of the substances appearing on the right of the reaction as written always appear in the numerator. For gases the units are always atmospheres, and for solutes the units are always mole fractions, or moles per 1000 g of water. For the constant K so defined, $\Delta F^0 = -RT \ln K$.

*Note that these are not the accepted I. C. T. values (see Vol. I, p. 17). The data of the present section form a consistent whole but cannot be readily combined with other data in I. C. T.

S	Entropie.
T	Température absolue.
V	Volume.
w	Masse molale.
γ	Coefficient d'activité.
μ	Force ionique.
μ_c	Force ionique (pour concentrations).
ν	Nombre d'ions formées par dissociation d'un molécule.
Δ	Incrément.

Petite majuscule romaine: Quantités moléculaires, ainsi μ .

Petite majuscule romaine avec barre: Quantité moléculaire partielle, ainsi $\bar{\mu}$.

L'indice ₁ (resp. ₂) identifie le solvant (resp. le corps dissous).

UNITÉS ET VALEURS DES CONSTANTES UTILISÉES*

1 cal.	4,182 joules.
T	$t + 273,1$.
R	82,07 cm ³ -atm. par deg. K.
R	1,9885 cal. par deg. K.
V	(pour une molécule gramme d'un gaz parfait) 22 412 cm ³ à 1 atm. et à 273, 1°K.
F	96 494 coulombs par equiv.
F	23 074 cal. par volt equiv.

Toutes les pressions sont exprimées en atmosphères, toutes les températures en degrés absolus, toutes les forces électromotrices en volts et toutes les quantités d'énergie en calories (*v. ci-dessus*), à moins d'une autre indication. Lorsqu'on veut effectuer des transformations ultérieures des données, il est important de n'utiliser que les constantes et les données de cette section.

DONNÉES RELATIVES À L'ÉNERGIE LIBRE

En général, on peut juger de la précision des équations relatives à l'énergie libre par la constance de la quantité I en consultant la table où celle-ci est mentionnée. Le manque d'une tendance définie avec la variation de la température indique que le choix de la forme particulière des substances prenant part à la réaction et des valeurs de ΔH et ΔC_p est probablement réellement exact. Les variations individuelles indiquent le degré de précision des mesures expérimentales. Comme plusieurs des valeurs dérivées comportent l'addition et la soustraction d'autres équations, il n'est pas possible, pour le moment, de donner l'erreur probable et le nombre de chiffres significatifs donnés ne doit pas être interprété comme une indication de la précision. Lorsque des valeurs "revised" sont indiquées, il est ordinairement nécessaire d'utiliser les valeurs non révisées (⁸⁸⁵), lorsque celles-ci doivent être combinées avec d'autres équations de la section.

Les énergies libres sont données sous la forme

$$\Delta F^0 = \Delta H_0^0 - \Delta \Gamma_0^0 T \ln T - \frac{1}{2} \Delta \Gamma' T^2 - \frac{1}{6} \Delta \Gamma'' T^3 - \dots + IT \quad (1)$$

où $\Delta \Gamma$, $\Delta \Gamma'$ et $\Delta \Gamma''$, etc., sont les coefficients dans l'expression algébrique de l'augmentation de la capacité calorifique de la réaction.

On a ainsi

$$\Delta H^0 = \Delta H_0^0 + \Delta \Gamma_0^0 T + \frac{1}{2} \Delta \Gamma' T^2 + \frac{1}{3} \Delta \Gamma'' T^3 \quad (2)$$

$$\Delta S^0 = \Delta \Gamma_0^0 (1 + \ln T) + \Delta \Gamma' T + \frac{1}{2} \Delta \Gamma'' T^2 + \dots - I \quad (3)$$

L'exposant ⁰ sur les quantités ΔF , ΔH , ΔS , indique que la quantité est celle se rapportant à une réaction établie ou implicite, dans laquelle toutes les substances chimiques engagées sont supposées être à l'activité unité, à une fugacité d'une atmosphère, (ou, lorsque cela est établi spécifiquement ainsi, à une pression d'une atm.), ou à une concentration unité hypothétique. Lorsque la réaction n'est pas établie explicitement, il s'agit d'une réaction de formation d'une substance donnée à partir de ses éléments dans leur état type. L'état type d'un élément est l'état pour lequel la

*À noter que celles-ci ne sont pas les valeurs I. C. T. acceptées (voir Vol. I, p. 17). Les données de la présente section constituent un tout consistant, mais elles ne peuvent être directement combinées avec les autres données dans les I. C. T.

In some cases we use equilibrium functions (K_m) in which the molality of the substances or ions is used instead of the activity, and others (K_c) in which the concentrations (moles per liter) of the substances in solution are used instead of the activities. In still others we have used special functions (K'_m or K'_c) in which activities are used for all the substances except the ions present. The concentration of a gas is never used in these expressions. See Lewis and Randall (885), Randall and Vietti (1192), Randall (1170.5).

ACTIVITY COEFFICIENTS

In the case of all reactions involving only ions on the right-hand side of the equation, and a few others, the various equilibria are transformed in such a way that $(\log \gamma + \text{a constant})$ and $\mu^{1/2}$ are given in the tables. By a simple graph of these quantities interpolations and comparisons may be made, and by superimposition of the curves so obtained upon the corresponding curves for suitable reference salts made upon the same scale, the extrapolation to unit activity coefficient can be easily made, and when these extrapolated numbers become available the activity coefficient of the particular pair of ions may be found by subtraction of $\log p.f.$ (given in a few cases) from the value of $(\log \gamma + \text{a constant})$. The activity coefficient for concentration, the ionic strength for concentration, etc., are defined in the sense used by Randall and Vietti (1192), namely, the product of the activity-coefficient-for-concentration by the concentration gives the activity (defined with reference to molalities).

$$\log \gamma + \text{const.} = \log \gamma - E^0/(0.00019844\nu T/N) = -E/(0.00019844\nu T/N) + \log (1/m_{\pm}) \quad (4)$$

where E^0 and E are the standard and measured electromotive forces, N the number of equivalents, and m_{\pm} the mean molality of the ions studied in the cell.* Or

$$\log \gamma + \text{const.} = (1/\nu) \log p + \log (1/m_{\pm}) \quad (5)$$

where p is the vapor pressure of the solute. Or

$$\log \gamma + \text{const.} = (1/\nu) \log x_2 + \log (1/m_{\pm})$$

where x_2 is the mole fraction of the solute in a second immiscible solvent. Or

$$\log \gamma + \text{const.} = \log (1/m_{\pm})$$

where m_{\pm} is the mean molality of the ions in equilibrium with the pure solid (solubility). Or

$$\log \gamma + \text{const.} = (1/\nu) \log (1/K'_m),$$

where K'_m is an equilibrium function in which activities are substituted for all substances taking part in the reaction (usually undissociable substances or gases) except the pair of ions considered. (See CaCO_3 (calcite) + $\text{H}_2\text{CO}_3(\text{aq}) = \text{Ca}^{++} + 2\text{HCO}_3^-$, p. 296.)

INHALT DIESER ABTEILUNG

Zu dieser Abteilung gehören alle Gleichgewichte bis auf solche welche in den vorhergehenden behandelt worden sind. Die Abteilung enthält auch verschiedene thermodynamische Daten wie partielle molare Grössen, Aktivitätskoeffizienten, Molwärmen der Substanzen, usw., wenn dieselben mit anderen Daten verbunden sind.

Die Tabellen sind nicht so vollständig wie man sich wünschen könnte. Es wurde versucht, möglichst verschiedenartige Systeme zu behandeln; jenen Systemen, welche in der Literatur nicht so ausführlich diskutiert worden sind, ist mehr Raum gewidmet als den gewöhnlicheren. Das Weglassen einer Tabelle, oder die blosse Zitierung einer Arbeit ist nie als eine Unterschätzung der Qualität oder Wichtigkeit der Daten zu betrachten.

ANORDNUNG

1. Die Systeme und Reaktionen sind nach der Standardanordnung (siehe Bd. III, S. viii) geordnet, dem Reaktionsteilnehmer mit der höchsten Schlüsselformel entsprechend. So sind zum

* In general $\Delta F = -NEF$.

valeur $\Delta F^0 = 0$ est assignée dans les tables, la pression étant toujours une atm. à moins d'une autre indication. Lorsque aucun état type n'est indiqué ainsi dans les tables, il s'agit de la forme "ordinaire" solide de l'élément.

En écrivant la constante d'équilibre, K , les activités des substances se trouvant au deuxième membre de la réaction sont écrites au numérateur comme d'habitude. Pour les gaz, les unités sont toujours atmosphères, et pour les corps dissous, les unités sont toujours fractions moléculaires grammes, ou molécules grammes pour 1000 g d'eau. Pour la constante K , ainsi définie, $\Delta F^0 = -RT \ln K$.

Dans quelques cas on s'est servi des fonctions d'équilibre (K_m), dans lesquelles la molalité des substances ou des ions est utilisée à la place de l'activité, et d'autres fonctions (K_c) dans lesquelles les concentrations (mol gr. par litre) des substances en solutions sont utilisées à la place des activités. Dans d'autres cas encore, il a été employé des fonctions spéciales (K'_m ou K'_c) dans lesquelles les activités ont été utilisées pour toutes les substances à l'exception des ions présents. La concentration d'un gaz n'est jamais utilisée dans ces expressions. Voir Lewis et Randall (885), Randall et Vietti (1192), Randall (1170.5).

COEFFICIENTS D'ACTIVITÉ

Dans le cas de toutes les réactions ne comportant que des ions au deuxième membre de l'équation, et dans quelques autres cas, les divers équilibres sont transformés de telle façon que $(\log \gamma + \text{une constante})$ et $\mu^{1/2}$ soient donnés dans les tables. Au moyen d'un simple graphique de ces quantités, on peut faire des interpolations et des comparaisons et par superposition des courbes ainsi obtenues avec les courbes correspondantes de sels de référence convenables, dessinées à la même échelle, on peut effectuer facilement l'extrapolation pour le coefficient unité d'activité; lorsque ces nombres extrapolés sont disponibles, on trouvera le coefficient d'activité de la paire particulière d'ions en soustrayant $\log p.f.$ (donné dans quelques cas) de la valeur de $(\log \gamma + \text{une constante})$. Le coefficient d'activité pour la concentration, la force ionique pour la concentration, etc., sont définis suivant le sens utilisé par Randall et Vietti (1192), c'est-à-dire, le produit du coefficient d'activité pour la concentration, par la concentration donne l'activité (définie avec référence aux molalité).

$$\log \gamma + \text{constante} = \log \gamma - E^0/0,00019844\nu T/N = -E/(0,00019844\nu T/N) - \log (1/m_{\pm}) \quad (4)$$

où E^0 et E sont respectivement les forces électromotrices types et mesurées, N le nombre des équivalents et m_{\pm} la molalité moyenne des ions étudiés dans la pile.* Ou

$$\log \gamma + \text{constante} = (1/\nu) \log p + \log (1/m_{\pm}) \quad (5)$$

où p est la pression de vapeur du corps dissous. Ou

$$\log \gamma + \text{constante} = (1/\nu) \log x_2 + \log (1/m_{\pm})$$

où x_2 est la fraction moléculaire du corps dissous dans un deuxième dissolvant non miscible. Ou

$$\log \gamma + \text{constante} = \log (1/m_{\pm})$$

où m_{\pm} est la molalité moyenne des ions en équilibre avec le solide pur (solubilité). Ou

$$\log \gamma + \text{constante} = (1/\nu) \log (1/K'_m)$$

où K'_m est une fonction d'équilibre dans laquelle les activités sont substituées à toutes les substances prenant part à la réaction (ordinairement des substances non dissociables ou des gaz), à l'exception de la paire d'ions considérés. (Voir CaCO_3 (calcite) + $\text{H}_2\text{CO}_3(\text{aq}) = \text{Ca}^{++} + 2\text{HCO}_3^-$, p. 296.)

ARGOMENTI COMPRESI IN QUESTO CAPITOLO

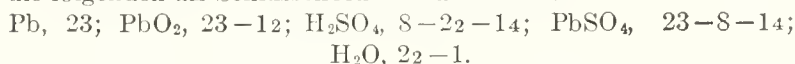
Questo capitolo comprende tutti gli equilibri chimici, eccettuati quelli dei quali si è parlato in capitoli precedenti. Vi sono pure contenuti dati termodinamici diversi, come quantità molari parziali, coefficienti di attività, capacità termiche, ecc.

* En général $\Delta F = -NEF$.

Beispiel in der Reaktion



die folgenden als Schlüsselformeln zu nehmen:



Die höchste Schlüsselformel ist jene für PbSO_4 , 23-8-14, und diese Reaktion wird deswegen unter PbSO_4 angegeben; man kann sie auffinden, indem man die Blätter des Bandes umschlägt, bis 23 als das erste Glied der Schlüsselnummern, die am oberen Ende jeder rechten Seite sind, erscheint. Nachdem die richtige Abteilung so gefunden worden ist, kann man das erwünschte System oder die erwünschte Reaktion nach Besichtigung festsetzen.

2. Wo es sich um eine Zustandwahl für die gegebene Substanz handelt, ist die Ordnung wie folgt: Gas (g); Flüssigkeit (l); fester Körper (s); in wässriger Lösung (aq); in nicht-wässriger Lösung, Standardanordnung nach Lösungsmitteln.

3. *Wichtige Ausnahmen.*—Feste Hydrate, Ammine, usw., Krystallwasser oder Krystall-Ammoniak enthaltend, stehen unter dem Lösungsmittel-freien Salz verzeichnet. Krystall-Wasser, -Ammoniak, usw., sind deswegen im Schreiben der Schlüsselformeln fortzulassen. (Diese Ausnahmen sind aber für Komplexionen, Komplexkobaltamine, usw., nicht gültig.) Löslichkeitsdaten sind immer unter der Schlüsselformel des gelösten Stoffes zu finden.

ZEICHEN UND ABKÜRZUNGEN

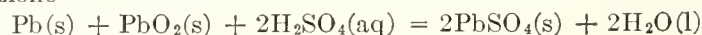
Im allgemeinen werden die Formelzeichen von Lewis und Randall (885) gebraucht. (Siehe auch die deutsche Übersetzung von Redlich.)

<i>a</i>	Aktivität.
<i>c</i>	Konzentration (Mol pro Liter).
<i>c_±</i>	Geometrisches Mittel der Ionenkonzentrationen.
<i>f</i>	Flüchtigkeit. (Fugazität).
het.	Zwei-Phasen System am reichsten an gelöstem Stoff.
ln	Natürlicher Logarithmus.
log	Dekadischer Logarithmus.
<i>m</i>	Molarer Gehalt (Mol pro 1000 g H_2O in vacuo, Molarität).
$\left. \begin{matrix} m_{\pm} \\ m_{\pm}^0 \end{matrix} \right\}$	Siehe S. 230.
<i>n</i>	Molzähl.
<i>p</i>	Dampfdruck (in Atmosphären).
<i>p.f.</i>	Proportionalitätsfaktor (siehe Aktivitätskoeffizienten).
<i>s</i>	Löslichkeit (Mol pro 1000 g H_2O in vacuo).
<i>s_c</i>	Löslichkeit (Mol pro Liter).
<i>t</i>	Temperatur, Grad Celsius.
<i>x</i>	Molenbruch.
<i>C_p</i>	Molwärme bei konstantem Druck.
<i>C_v</i>	Molwärme bei konstantem Volumen.
<i>E</i>	Innere Energie.
<i>E</i>	Elektromotorische Kraft.
<i>E⁻</i>	Ein Gramm-Atom Äquivalent negativer Elektrizität.
<i>F</i>	Freie Energie.
<i>H</i>	Wärmeinhalt.
<i>I</i>	Integrationskonstante.
<i>K</i>	Gleichgewichtskonstante (Aktivitäten) siehe S. 230.
<i>K'</i>	Spezielle Gleichgewichtsfunktion.
<i>K_c</i>	Gleichgewichtsfunktion in Konzentrationen ausgedrückt.
<i>K_m</i>	Gleichgewichtsfunktion in Molaritäten ausgedrückt.
<i>K_p</i>	Gleichgewichtsfunktion in Partialdrücken ausgedrückt.
<i>L</i>	Relativer partieller molare Wärmeinhalt.
<i>M</i>	Molar.
<i>P</i>	Gesamtdruck oder Dampfdruck in Atmosphären.
<i>R</i>	Gaskonstante.
<i>S</i>	Entropie.
<i>T</i>	Absolute Temperatur.
<i>V</i>	Volumen.
<i>w</i>	Molare Masse (Molekulargewicht).

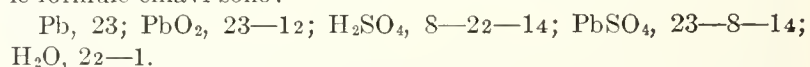
Le tabelle però non sono così complete come si potrebbe desiderare. Si è cercato di includervi il maggior numero possibile di tipi di sistemi, e sono stati trattati con maggiore estensione i sistemi non ampiamente discussi nella letteratura, anziché quelli più comuni. Il fatto che qualche tabella sia stata omessa o che dei dati siano stati semplicemente citati non indica nulla rispetto alla qualità e alla importanza di essi.

DISPOSIZIONE

1. I sistemi e le reazioni sono elencate con l'ordinamento standard (vedi Vol. III, p. viii) seguendo l'ordine delle sostanze che hanno la formula-chiave più alta. Così, per esempio, nella reazione



le formule-chiavi sono:



La formula-chiave più alta è quella del PbSO_4 , 23-8-14 e quindi questa reazione si troverà elencata sotto PbSO_4 e si troverà dove il 23 apparirà come il primo membro dei numeri-chiave che stanno in cima ad ogni pagina di destra. Stabilita a questo modo la sezione si può trovare il sistema di reazione per ispezione.

2. Quando una data sostanza è considerata in diversi stati, allora l'ordine è il seguente: gas (g); liquido(l); solido(s) in soluzione acquosa (aq); in soluzione non acquosa l'ordine è quello standard dei solventi.

3. *Eccezioni Importanti.*—Gli idrati solidi, le ammine, ecc., che contengono acqua, ammoniaca, ecc. "di cristallizzazione" sono elencati sotto la sostanza originaria. L'acqua, l'ammoniaca, ecc., di cristallizzazione dovrà essere tralasciata nello scrivere la formula-chiave. (Queste eccezioni non si riferiscono tuttavia agli ioni complessi, alle cobaltamine complesse, ecc.) I dati di solubilità sono in ogni caso elencati sotto i soluti.

ABBREVIAZIONI E SIMBOLI

In genere viene impiegata l'annotazione di Lewis e Randall (885).

<i>a</i>	Aattività.
<i>c</i>	Concentrazioni (moli per litro).
<i>c_±</i>	Media geometrica della concentrazione degli ioni.
<i>f</i>	Fugacità.
het.	Sistema di due fasi più ricco in soluto.
ln	Logaritmo a base <i>e</i> .
log	Logaritmo a base 10.
<i>m</i>	Molarità (moli per 1000 g di H_2O , nel vuoto).
$\left. \begin{matrix} m_{\pm} \\ m_{\pm}^0 \end{matrix} \right\}$	v. p. 230.
<i>n</i>	Numero di moli.
<i>p</i>	Tensione di vapore (in atmosfere).
<i>p.f.</i>	Fattore di proporzionalità (vedi coefficienti di attività).
<i>s</i>	Solubilità (moli per 1000 g H_2O , nel vuoto).
<i>s_c</i>	Solubilità (moli per litro).
<i>t</i>	Temperatura, °C.
<i>x</i>	Frazione di mole.
<i>C_p</i>	Capacità termica molare a pressione costante.
<i>C_v</i>	Capacità termica molare a volume costante.
<i>E</i>	Energia interna.
<i>E</i>	Forza elettromotrice.
<i>E⁻</i>	Un grammo atomo di elettricità negativa.
<i>F</i>	Energia libera.
<i>H</i>	Contenuto termico.
<i>I</i>	Costante d'integrazione.
<i>K</i>	Costante di equilibrio (attività) v. p. 230.
<i>K'</i>	Funzione speciale di equilibrio.
<i>K_c</i>	Funzione d'equilibrio espressa in concentrazioni.

γ	Aktivitätskoeffizient.
μ	Ionenstärke.
μ_c	Ionenstärke (für Konzentrationen).
ν	Anzahl Ionen, die bei Dissoziation einer Molekül gebildet werden.
Δ	Zuwachs.
Kleingedruckte lateinische Grossbuchstaben, z. B. h , bedeuten molare Grössen.	
Kleingedruckte lateinische Grossbuchstaben überstrichen, z. B. \bar{h} , bedeuten partielle molare Grössen.	
Index $_1$ (bzw. $_2$) entspricht dem Lösungsmittel (bzw. gelöstem Stoff).	

EINHEITEN UND WERTE DER GEBRAUCHTEN KONSTANTEN*

1 cal.	4,182 Joule.
T	$t + 273,1$.
R	82,07 cm ³ -Atm. pro Grad K.
R	1,9885 Kal. pro Grad K.
V	(für einem Mol eines idealen Gases) 22 412 cm ³ bei 1 Atm. und 273,1°K.
F	96 494 Coulomb pro Äquiv.
F	23 074 Kal. pro Volt Äquiv.

Alle Drucke sind in Atmosphären, alle Temperaturen in Grad absolut, alle elektromotorischen Kräfte in Volt, und alle Energiegrössen in Kalorien (*siehe* weiter oben) ausgedrückt, wenn nicht ausdrücklich anders angegeben ist. Bei weiterer rechnerischer Verwendung dieser Daten ist es wichtig nur die Konstanten und Daten dieser Abteilung zu gebrauchen.

DATEN DER FREIEN ENERGIE

Im allgemeinen kann man die Genauigkeit der Gleichungen für die freie Energie nach der Konstanz der Grösse I beurteilen, wenn letztere tabellarisiert ist. Das Ausbleiben einer bestimmten Richtung der Konstante bei einer Temperaturänderung zeigt, dass die Wahl dieser besonderen Formen der Reaktionsteilnehmer, sowohl wie die Werte von ΔH und ΔC_p wahrscheinlich richtig ist. Die einzelnen Abweichungen zeigen den Präzisionsgrad der experimentellen Messungen. Da viele der abgeleiteten Werte durch Addition und Subtraktion anderer Gleichungen erhalten worden sind, ist es zu dieser Zeit nicht möglich, die Grösse des wahrscheinlichsten Fehlers anzugeben; die Zahl der angegebenen Ziffern soll deswegen nicht als Mass der Genauigkeit genommen werden. Wo "revised" Werte angegeben sind, ist es gewöhnlich nötig dass man die nicht revidierten (885) Werte gebraucht, wenn man solche Daten mit anderen der Abteilung kombinieren will.

Die freien Energien sind in folgender Form gegeben

$$\Delta F^0 = \Delta H_0^0 - \Delta \Gamma_0^0 T \ln T - \frac{1}{2} \Delta \Gamma'^0 T^2 - \frac{1}{6} \Delta \Gamma''^0 T^3 - \dots + IT \quad (1)$$

wo $\Delta \Gamma$, $\Delta \Gamma'$, $\Delta \Gamma''$, usw., die Koeffizienten in dem algebräischen Ausdruck für die Zunahme des Wärmeinhalts während der Reaktion sind.

So haben wir

$$\Delta H^0 = \Delta H_0^0 + \Delta \Gamma_0^0 T + \frac{1}{2} \Delta \Gamma'^0 T^2 + \frac{1}{3} \Delta \Gamma''^0 T^3 \quad (2)$$

$$\Delta S^0 = \Delta \Gamma_0^0 (1 + \ln T) + \Delta \Gamma'^0 T + \frac{1}{2} \Delta \Gamma''^0 T^2 + \dots - I \quad (3)$$

Der Index 0 an den Grössen ΔF , ΔH , ΔS bedeutet dass die Grösse zu einer angegebenen oder angedeutenden Reaktion gehört, in welcher alle teilnehmenden chemischen Substanzen bei Aktivität Eins, bei einer Flüchtigkeit von 1 Atm. (oder, wenn es besonders angegeben ist, bei einem Druck von 1 Atm.), oder bei

* Es ist zu beachten dass diese Werte nicht diejenigen sind welche sonst in den I. C. T. (*siehe* Bd. I, S. 17) angenommen wurden. Die Daten dieser Abteilung bilden unter sich ein einheitliches System, aber können nicht leicht mit anderen Daten in den I. C. T. kombiniert werden.

K_m	Funzione d'equilibrio espressa in molarità.
K_p	Funzione d'equilibrio in termini delle pressioni parziali.
\bar{L}	Contenuto termico molare relativo parziale.
M	Molare.
P	Pressione totale o tensione di vapore in atmosfere.
R	Costante dei gas.
S	Entropia.
T	Temperatura assoluta.
V	Volume.
w	Massa molare.
γ	Coefficiente di attività.
μ	Forza ionica.
μ_c	Forza ionica per le concentrazioni.
ν	Numero degli ioni formati per la dissociazione d'una molecola.
Δ	Incremento.
Let. cap. rom. piccola. Quantità molari, per esempio u .	
Let. cap. rom. pic. sbarrata. Quantità molari parziali, per esempio \bar{u} .	
L'indicazione sottoscritta $_1$ (risp. $_2$) si riferisce al solvente (risp. soluto).	

UNITÀ E VALORI DELLE COSTANTI IMPIEGATE*

1 cal.	4,182 joules.
T	$t + 273,1$.
R	82,07 cm ³ -atm. per grado K.
R	1,9885 cal. per grado K.
V	(per una mole di gas perfetto) 22 412 cm ³ a 1 atm. e 273,1°K.
F	96 494 coulombs per equiv.
F	23 074 cal. per volt equiv.

Tutte le pressioni sono espresse in atmosfere, tutte le temperature in gradi assoluti, tutte le forze elettromotrici in volte e tutte le quantità di energia in calorie (*v. sopra*) a meno che non venga espressamente altrimenti indicato. Nel fare ulteriori trasformazioni dei dati è importante che vengano usati solo le costanti e i dati di questo capitolo.

DATI SULL'ENERGIA LIBERA

In genere, l'accuratezza delle equazioni dell'energia libera può essere giudicata dalla costanza di I , dove questo è riportato. Quando il valore di I non mostra tendenza a variare con la temperatura deve ritenersi che la scelta delle forme particolari delle sostanze prendenti parte alla reazione, e i valori di ΔH e ΔC_p sono da ritenersi con probabilità sostanzialmente corretti. Le singole variazioni indicano il grado di accuratezza delle misure sperimentali. Siccome molti dei valori dedotti implicano la addizione e la sottrazione di altre equazioni, non è possibile, oggi, indicare l'errore probabile; non bisogna prendere quindi come indice di accuratezza il numero delle cifre riportate. Dove sono riportati valori "revised" bisognerà usare i valori non corretti (885) quando dovranno essere combinati con altre equazioni di questo capitolo.

Le energie libere sono date nella forma

$$\Delta F^0 = \Delta H_0^0 - \Delta \Gamma_0^0 T \ln T - \frac{1}{2} \Delta \Gamma'^0 T^2 - \frac{1}{6} \Delta \Gamma''^0 T^3 - \dots + IT \quad (1)$$

dove $\Delta \Gamma$, $\Delta \Gamma'$ e $\Delta \Gamma''$, ecc., sono i coefficienti dell'incremento della capacità termica della reazione nell'espressione algebrica.

Così si ha:

$$\Delta H^0 = \Delta H_0^0 + \Delta \Gamma_0^0 T + \frac{1}{2} \Delta \Gamma'^0 T^2 + \frac{1}{3} \Delta \Gamma''^0 T^3 \quad (2)$$

$$\Delta S^0 = \Delta \Gamma_0^0 (1 + \ln T) + \Delta \Gamma'^0 T + \frac{1}{2} \Delta \Gamma''^0 T^2 + \dots - I \quad (3)$$

* Nota bene che questo *non sono* i valori accettati dalle I. C. T. (*vedi* Vol. I, p. 17). I dati di questa sezione formano un tutto unico, ma non possono essere combinati senz'altro con gli altri dati delle I. C. T.

einer hypothetischen Konzentration Eins angenommen sind. Ist die Reaktion nicht ausdrücklich angegeben, so wird angenommen, dass es sich um jene Reaktion handelt, in welcher eine gegebene Substanz aus ihren Elementen in dessen Normalzuständen gebildet wird. Der Normalzustand ist jener, welchem in den Tabellen der Wert $\Delta F^0 = 0$ zugeteilt ist, wobei der Druck immer 1 Atm. sein soll, falls kein anderer Wert dafür besonders angegeben wird. Im Fall, dass kein Normalzustand in den Tabellen derart angegeben ist, nimmt man den "gewöhnlichen" festen Zustand des Elementes an.

Die Gleichgewichtskonstante, K , ist immer so definiert, dass die Aktivitäten der Substanzen, welche rechts in der geschriebenen Reaktionsgleichung erscheinen, im Zähler stehen. Für Gase sind die Einheiten immer Atmosphäre, und für gelöste Stoffe immer Molenbrüche, oder Mol pro 1000 g Wasser. Für die Konstante K auf diese Weise definiert, ist $\Delta F^0 = -RT \ln K$.

In einigen Fällen gebrauchen wir Gleichgewichtsfunktionen (K_m), in welchen, anstatt Aktivitäten, die Molarität der Substanzen oder Ionen gebraucht wird, und andere (K_c) in welchen die Aktivitäten durch Konzentrationen (Mol pro Liter) ersetzt sind. In noch anderen Fällen haben wir Spezialfunktionen (K'_m oder K'_c) gebraucht, in welchen für alle Substanzen, ausser den Ionen, Aktivitäten benutzt worden sind. Die Konzentration eines Gases kommt in solchen Ausdrücken nie vor. Siehe Lewis und Randall (885), Randall und Vietti (1192), und Randall (1170.5).

AKTIVITÄTSKOEFFIZIENTEN

Im Falle aller Reaktionen, welche auf der rechten Seite nur Ionen enthalten, und etlicher anderer, sind die verschiedenen Gleichgewichte so umgeformt, dass $(\log \gamma + \text{Konstante})$ und $\mu^{1/2}$ in den Tabellen angegeben sind. Durch einfache graphische Auftragung dieser Grössen, kann man Interpolieren und Vergleiche ausführen; durch Auflegen der so erhaltenen Kurven auf entsprechende Kurven in demselben Massstabe für passende Bezugssalze kann man leicht zum Aktivitätskoeffizienten Eins extrapolieren. Wenn diese extrapolierten Grössen vorhanden sind, kann der Aktivitätskoeffizient für das betreffende Ionenpaar durch Subtraktion von $\log p.f.$ (in einigen Fällen angegeben) von dem Wert der Grösse $(\log \gamma + \text{Konstante})$ erhalten werden. Der Aktivitätskoeffizient für Konzentration, die Ionenstärke für Konzentration, usw., sind in dem Sinne Randall und Vietti (1192) definiert, nämlich so, dass die Aktivität (in Bezug auf Molaritäten definiert) gleich ist dem Produkt von dem besagten Konzentrationsaktivitätskoeffizient und der Konzentration.

$$\log \gamma + \text{Konstante} = \log \gamma - E^0/(0,00019844 \nu T/N) = E/(0,00019844 \nu T/N) + \log (1/m_{\pm}) \quad (4)$$

wo E^0 die normalen und E die gemessenen elektromotorischen Kräfte, N die Nummer der Äquivalenten, und m_{\pm} die mittlere Molarität der Ionen in der Kette bedeutet*. Oder

$$\log \gamma + \text{Konstante} = (1/\nu) \log p + \log (1/m_{\pm}) \quad (5)$$

wo p der Dampfdruck des gelösten Stoffes ist. Oder

$$\log \gamma + \text{Konstante} = (1/\nu) \log x_2 + \log (1/m_{\pm})$$

wo x_2 den Molenbruch gelösten Stoffes in einem zweiten unvermischbaren Lösungsmittel bedeutet. Oder

$$\log \gamma + \text{Konstante} = \log (1/m_{\pm})$$

wo m_{\pm} die mittlere Molarität der Ionen in Gleichgewicht mit dem reinen festen Stoffe (Löslichkeit) ist. Oder

$$\log \gamma + \text{Konstante} = (1/\nu) \log (1/K'_m)$$

wo K'_m eine Gleichgewichtsfunktion ist, in welcher für alle Reaktionsteilnehmer (am gewöhnlichsten undissoziierbare Stoffe oder Gase) bis auf das betrachtete Ionenpaar, Aktivitäten eingesetzt worden sind. (Siehe $\text{CaCO}_3(\text{Calcite}) + \text{H}_2\text{CO}_3(\text{aq}) = \text{Ca}^{++} + 2\text{HCO}_3^-$, S. 296.)

* In allgemeinen $\Delta F = NEF$.

Il contrassegno ^o sulle quantità ΔF , ΔH , ΔS , indica che esse si riferiscono ad una reazione in cui tutte le sostanze che vi partecipano vengono considerate a una attività unitaria, a una fugacità di 1 atm. (oppure, quando sia specificamente indicato, alla pressione di 1 atmosfera) o a una concentrazione unitaria ipotetica. Quando la reazione non è esplicitamente indicata, si suppone sia quella di formazione di una data sostanza dagli elementi, nei loro stati standard. Lo stato standard di un elemento è quello per il quale nelle tabelle viene dato il valore $\Delta F^0 = 0$, la pressione essendo sempre di 1 atm. salvo che non venga altrimenti indicato. Quando nelle tabelle non è indicato nessuno stato standard, si tratta della forma solida "ordinaria" dell'elemento.

Nello scrivere la costante di equilibrio, K , le attività delle sostanze del membro di destra della reazione, come essa viene comunemente scritta, appaiono sempre al numeratore. Per i gas le unità sono sempre atmosfere, e per i soluti frazioni di moli o moli per 1000 g di acqua. Per la costante K così definita, $\Delta F^0 = -RT \ln K$.

In alcuni casi è fatto uso di funzioni di equilibrio (K_m) nelle quali invece dell'attività si impiega la molarità delle sostanze o dei ioni, in altri casi (K_c) nelle quali le concentrazioni (moli per litro) delle sostanze in soluzioni sono impiegate invece dell'attività. In altri casi sono state impiegate speciali funzioni (K'_m , o K'_c) nelle quali le attività sono usate per tutte le sostanze tranne che per gli ioni presenti. La concentrazione di un gas non viene mai impiegata in queste espressioni. Vedi Lewis e Randall (885), Randall e Vietti (1192), Randall (1170.5).

COEFFICIENTI DI ATTIVITÀ

Nel caso delle reazioni che implicano solo gli ioni del membro di destra dell'equazione, e in pochi altri casi, i vari equilibri vengono trasformati in modo che nelle tabelle sono riportati $(\log \gamma + \text{una costante})$ e $\mu^{1/2}$. Con un semplice grafico, si potranno fare interpolazioni e confronti. Sovrapponendo le curve così ottenute ad altre corrispondenti (di sali di riferimento opportunamente scelti, e disegnate sulla stessa scala) si può facilmente fare l'estrapolazione rispetto al coefficiente di attività unitaria. Quando si abbiano questi valori estrapolati si può trovare il coefficiente di attività di questa particolare coppia di ioni sottraendo $\log p.f.$ (dato in pochi casi) dal valore di $(\log \gamma + \text{una costante})$. Il coefficiente di attività per concentrazione, la forza ionica per concentrazione, ecc., sono definite nel senso in cui sono state impiegate da Randall e Vietti (1192), cioè il prodotto del coefficiente d'attività per concentrazione moltiplicato per la concentrazione dà l'attività (definita riferendosi alle molarità).

$$\log \gamma + \text{const.} = \log \gamma - E^0/(0,00019844 \nu T/N) =$$

$$-E/(0,00019844 \nu T/N) + \log (1/m_{\pm}) \quad (4)$$

dove E^0 e E sono le forze elettromotrici standard e misurate, N il numero degli equivalenti e m_{\pm} la molarità media degli ioni studiati nella cella.* Oppure

$$\log \gamma + \text{const.} = (1/\nu) \log p + \log (1/m_{\pm}) \quad (5)$$

dove p è la tensione di vapore del soluto. Oppure

$$\log \gamma + \text{const.} = (1/\nu) \log x_2 + \log (1/m_{\pm})$$

dove x_2 è la frazione molare del soluto in un secondo solvente immiscibile. Oppure

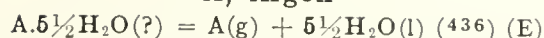
$$\log \gamma + \text{const.} = \log (1/m_{\pm})$$

dove m_{\pm} è la molarità media degli ioni in equilibrio con il solido puro (solubilità). Oppure

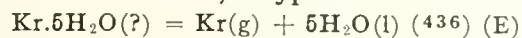
$$\log \gamma + \text{const.} = (1/\nu) \log (1/K'_m),$$

dove K'_m è una funzione d'equilibrio nella quale si sono sostituite le attività per tutte le sostanze che prendono parte alla reazione (generalmente sostanze indissociabili o gas) eccettuata la coppia di ioni presa in considerazione. (Vedi $\text{CaCO}_3(\text{calcite}) + \text{H}_2\text{CO}_3(\text{aq}) = \text{Ca}^{++} + 2\text{HCO}_3^-$, p. 296.)

* In generale $\Delta F = NEF$.

A, Argon

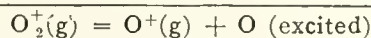
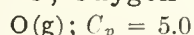
<i>T</i>	233.9	273.3	281.1	ΔH
<i>P_A</i>	(1) (extrap.)	98.5	210	14 885

Kr, Krypton

$$\Delta H = 14\,710$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
248.3	(1.0) (extrap.)	279.1	26.00
273.1	14.50	281.1	30.91
275.1	17.78	283.1	37.58
277.1	21.38	285.1*	45.19

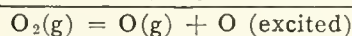
* Critical decomposition point, *T* = 285.6 to 286.1°K.

O, Oxygen

$$\Delta H = 150\,000, \text{ band spectra (110); cf. Vol. V, p. 418}$$



$$\Delta H^0 = 0; \Delta F^0 = 0 \text{ (877, 885); } C_p = 6.5 + 0.0010T \text{ (876, 885)}$$



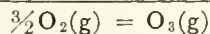
$$\Delta H = 162\,000, \text{ band spectra (110); } = 150\,000, \text{ positive ray analysis (637, 638); cf. Vol. V, p. 418}$$



$$\Delta F_{298.1}^0 = 3904, \text{ from solubility in water (468); for activity coefficient in aqueous salt solutions, v. (1175)}$$



$$C_p = 7.0 + 0.0071T - 0.00000186T^2 \text{ (877, 885)}$$



$$\Delta H = 34\,600 - 2.75T + 0.028T^2 - 0.00000062T^3 \text{ (885); } \Delta F^0 = 34\,600 + 2.75T \ln T - 0.0028T^2 + 0.00000031T^3 - 22.4T \text{ (425, 885, 922, 923); cf. (400, 943, 1228, 1503, 1504); } \Delta F_{298.1}^0 = 32\,400$$

H, Hydrogen

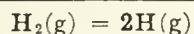
$$C_p = 5.0; \Delta F_{298.1}^0 = 45\,730 \text{ (885); see } H_2 = 2H$$



ΔF^0 , ΔH^0 and all partial molal quantities are arbitrarily taken equal to 0



$$\Delta F^0 = 0; \Delta H^0 = 0 \text{ (877, 885); } C_p = 6.5 + 0.0009T \text{ (876, 885)}$$



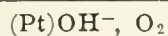
$$\Delta F^0 = 97\,000 - 3.5T \ln T + 0.00045T^2 + 1.17T; \Delta F_{298.1}^0 = 91\,460 \text{ (825, 826, 827, 829, 885); cf. (309, 1545, 1546, 1547) and Vol. V, p. 418}$$



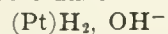
$$\Delta F_{298.1}^0 = 4182, \text{ from solubility in water (468); for activity coefficient in aqueous salt solutions, v. (1175)}$$



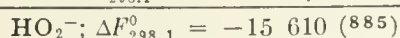
$$\Delta F_{298.1}^0 = -37\,455 \text{ (885)}$$



$$E_{298.1}^0 = -0.3976 \text{ (885); } [OH^- = \frac{1}{4}O_2(g) + \frac{1}{2}H_2O(l) + E^-; \Delta F_{298.1}^0 = 9175]$$



$$E_{298.1}^0 = 0.8280 \text{ (877, 885); } [\frac{1}{2}H_2(g) + OH^- = H_2O(l) + E^-; \Delta F_{298.1}^0 = -19\,105]$$



$$C_p = 8.81 - 0.0019T + 0.00000222T^2 \text{ (885); see } H_2(g) + \frac{1}{2}O_2(g) = H_2O(g)$$

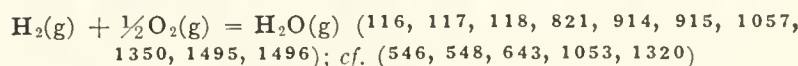


Activity function of water vapor in mixtures with hydrogen and with nitrogen at 323.1°K

<i>P</i> (atm.)	<i>x</i> ₂ in H ₂	<i>k</i> ₂ in H ₂	<i>k</i> ₂ / <i>P</i> in H ₂	<i>x</i> ₂ in N ₂	<i>k</i> ₂ in N ₂	<i>k</i> ₂ / <i>P</i> in N ₂
100	0.1391	93.8	0.938	0.1576	82.8	0.828
200	.0785	178.0	.890	.1001	139.6	.698
300	.0582	257.1	.857	.0796	188.0	.627
400	.0473	338.7	.847	.0684	234.1	.585
500	.0408	420.0	.840	.0623	275.0	.550
600	.0364	504.0	.840	.0584	318.0	.530
700	.0334	586.5	.838	.0551	355.6	.508
800	.0312	671.5	.839	.0527	397.4	.497
900	.0294	761.0	.845	.0505	443.0	.492
1000	.0282	849.0	.849	.0486	493.0	.493

Activity function of water vapor in mixtures with 3:1 hydrogen-nitrogen at 298.1, 310.6 and 323.1°K

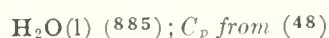
<i>P</i> (atm.)	298.1°K			310.6°K			323.1°K		
	<i>x</i> ₂	<i>k</i> ₂	<i>k</i> ₂ / <i>P</i>	<i>x</i> ₂	<i>k</i> ₂	<i>k</i> ₂ / <i>P</i>	<i>x</i> ₂	<i>k</i> ₂	<i>k</i> ₂ / <i>P</i>
100	0.0385	87.3	0.873	0.0768	89.0	0.890	0.1451	89.9	0.899
200	.0234	154.7	.773	.0449	163.3	.817	.0846	165.0	.825
300	.0183	212.5	.708	.0341	230.9	.770	.0631	237.1	.790
400	.0157	266.8	.667	.0287	294.1	.735	.0521	307.2	.768
500	.0140	321.5	.643	.0254	377.0	.724	.0460	372.5	.745
600	.0128	377.8	.630	.0231	420.0	.700	.0417	439.5	.732
700	.0120	433.0	.619	.0214	487.0	.696	.0386	508.0	.726
800	.0113	494.5	.618	.0200	558.0	.697	.0362	579.0	.724
900	.0108	556.0	.618	.0189	632.0	.702	.0344	651.0	.723
1000	.0104	620.0	.620	.0181	702.0	.702	.0328	729.0	.729



$$\Delta H_{298.1} = 57\,820; \Delta F_{298.1}^0 = -54\,507; \Delta F^0 = -57\,410 + 0.94T \ln T + 0.00165T^2 - 0.00000037T^3 + 3.92T \text{ (885)}$$

<i>T</i>	% dissoe.	log <i>K</i>	<i>I</i>	Mean <i>I</i>	Lit.
1 397	0.0078	6.312	3.81	3.81	(1057)
1 480	.0184	5.753	3.94		
1 561	.0340	5.354	3.67		
1 705	.0326	4.362		3.71	(914, 915)
1 783	.0778	4.260			
1 863	.211	3.826			
1 968	.373	3.579			
2 155	1.18	3.039	3.67	3.62	(1495, 1496)
2 257	1.77	2.771	3.57		
1 325	0.00325	6.884		3.55	(821)
1 354	.0049	6.616			
1 393	.0069	6.393			
1 433	.0103	6.129			
1 455	.0142	5.922			
1 474	.0141	5.927			
1 531	.0255	5.540			
1 550	.0287	5.464			

<i>T</i>	% dissoe.	log <i>K</i>	Lit.	<i>T</i>	% dissoe.	log <i>K</i>	Lit.
2 642	4.3	2.188	(116, 117, 118)	2 337	2.8	2.470	(1350)
2 698	7.5	1.813		2 505	4.5	2.105	
2 761	6.6	1.898		2 684	6.2	1.945	
2 834	9.8	1.626		2 731	8.2	1.755	
2 929	11.1	1.554		3 092	13.0	1.430	

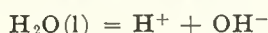


$$\Delta H_{273.1} = -68\,470; \Delta H_{291.1} = -68\,330; \Delta H_{298.1} = -68\,270; \\ \Delta F_{298.1}^0 = -56\,560; \Delta F^0 = -70\,650 - 8.0T \ln T + 92.84T$$

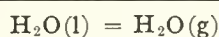
$t, ^\circ\text{C}$	Sp. heat	C_p	$t, ^\circ\text{C}$	Sp. heat	C_p
0	1.0092	18.182	50	0.9978	17.98
5	1.0051	18.108	60	0.9989	18.00
10	1.0021	18.054	70	1.000	18.02
15	1.0001	18.018	80	1.002	18.05
20	0.9988	17.994	90	1.004	18.09
25	.9979	17.978	100	1.006	18.12
30	.9974	17.969	125	1.012	18.23
35	.9972	17.966	150	1.019	18.36
40	.9972	17.966	200	1.026	18.48

Fugacity of liquid water at various temperatures and pressures (1190)

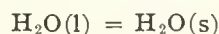
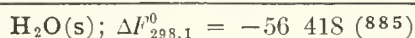
P (atm.)	a (298.1°)	a (310.6°)	a (323.1°)	f (298.1°)	f (310.6°)	f (323.1°)
1	1	1	1	0.03125	0.06372	0.1219
100	1.0757	1.0728	1.0703	.03362	.06836	.13047
200	1.1576	1.1515	1.1461	.03618	.07337	.13971
300	1.2454	1.2356	1.2270	.03892	.07873	.14957
400	1.3394	1.3254	1.3132	.04186	.08445	.16009
500	1.4402	1.4214	1.4050	.04501	.09057	.17127
600	1.5481	1.5240	1.5029	.04838	.09711	.18320
700	1.6637	1.6336	1.6072	.05199	.10409	.19592
800	1.7874	1.7506	1.7184	.05586	.11155	.20947
900	1.9200	1.8755	1.8367	.06000	.11951	.22389
1000	2.0618	2.0089	1.9628	.06443	.12801	.23927



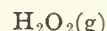
$$K_{298.1} = 1.005 \times 10^{-14} \text{ (885)}; \text{from (877, 911)}; \Delta H = 29\,210 - 53T, \text{ or } \Delta C_p = -53; \Delta H_{291.1} = 13\,780 \text{ (1544.5)}; \Delta F^0 = 29\,210 + 53T \ln T - 335.86T; K_{273.1} = 0.114 \times 10^{-14}; K_{291.1} = 0.58 \times 10^{-14} \text{ (885)}; \text{see further Vol. VI, p. 152 and Vol. V, p. 212}$$



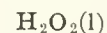
$$\Delta F_{298.1}^0 = 2\,053 \text{ (885)} \text{ from (1301)}; P_{298.1} = 23.8 \text{ mm}; \text{see also (337)}; \Delta H_{273.1} = 9\,730; \Delta H_{298.1} = 10\,450 \text{ (885)} \text{ from (1222, 1368)}; \text{see further Vol. V, p. 138}$$



$$\Delta C_p = -9.11 - 0.0336(273.1 - T); \Delta H_{273.1} = -1438 \text{ (885, 1262)} \text{ from (858, 1367)}; \text{see further Vol. V, p. 95, 131}$$



$$C_p = 7.5 + 0.0042T \text{ (877, 885)}; \Delta F^0 = -31\,200 + 5.5T \ln T - 0.00115T^2 - 9.3T; \Delta F_{298.1}^0 = -24\,730 \text{ (877, 885)}$$



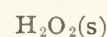
$$C_p = 19.7 \text{ (926)}; \Delta F_{298.1}^0 = -28\,230 \text{ (877, 885)}$$



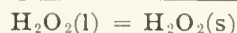
$$\Delta H_{347} = 12\,300; \Delta F_{298.1}^0 = 3\,500 \text{ (885)}$$

T	P	T	P
342.1	0.038	417.1*	1.000
358.1	.086		

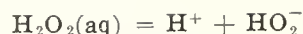
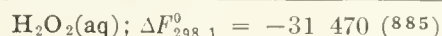
* Extrapolated (885).



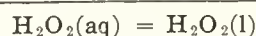
$$C_p = 16.0 \text{ (926)}; \Delta F_{298.1}^0 = -27\,980 \text{ (885)}$$



$$\Delta H_{271.4} = -2\,516 \text{ (926)}; \text{cf. Vol. V, p. 131}; \Delta F^0 = -1\,512 + 3.7T \ln T - 15.16T; \Delta F_{298.1}^0 = 252; \Delta H_{298.1}^0 = -2\,615 \text{ (885)}$$



$$K_{273.1} = 0.67 \times 10^{-12}; K_{298.1} = 2.4 \times 10^{-12} \text{ (743)}; \Delta F_{298.1}^0 = 15\,860 \text{ (885)}$$

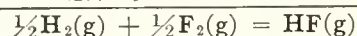
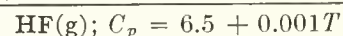


$$\Delta F_{298.1}^0 = 3\,240 \text{ (885)} \text{ from (926)}$$

F, Fluorine

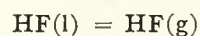


$$\Delta H^0 = 0; \Delta F^0 = 0; C_p = 6.5 + 0.0011T \text{ (885)}$$



$$\Delta F^0 = -32\,240 + 2.41T; \Delta F_{298.1}^0 = -31\,800 \text{ (1018)}; \Delta S_{298.1}^0 = 2.41 \text{ (833)}$$

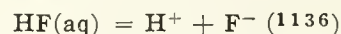
T	E (volts)	$\log P$	ΔF^0
496	1.505	-1.261	-31\,800
497	1.479	-1.277	-31\,200
497	1.484	-1.277	-31\,300
497	1.486	-1.277	-31\,300
504	1.489	-1.217	-31\,500
508	1.477	-1.217	-31\,200
518	1.480	-1.101	-31\,000
519	1.466	-1.097	-31\,200
521	1.467	-1.081	-31\,100
521	1.468	-1.081	-31\,100
521	1.467	-1.081	-31\,100
534	1.456	-0.981	-31\,100
534	1.460	-0.981	-31\,200
538	1.452	-0.953	-31\,000
538	1.448	-0.953	-30\,900
545	1.445	-0.901	-31\,000
545	1.441	-0.901	-30\,950



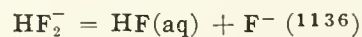
Mol. wt. of HF(l) (1352); vapor pressure, 192 to 320°K (1351)

T	P	w^*
234	0.0739	87.4
252	.1895	81.6
263	.3079	74.3
273	.4789	67.6
278.3	.5737	69.3
281.6	.6461	64.3
285.0	.7579	69.5
289.0	.8697	47.7
298.1	1.186	

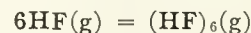
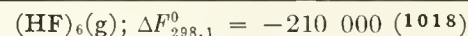
* w = apparent Mol. wt.



$$K_{298.1} = 7.2 \times 10^{-4} \text{ (conductivity)}; \Delta F_{298.1}^0 = 4300$$

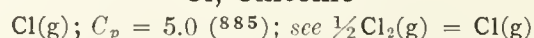


$$K_{298.1} = 0.182; \Delta F_{298.1}^0 = 1000$$

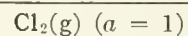


$$\Delta H_{298.1} = -40\,000; \Delta F_{298.1}^0 = -19\,200 \text{ (1352)} \text{ from (1441)}$$

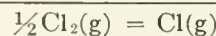
Cl, Chlorine



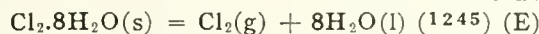
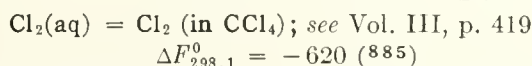
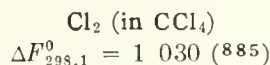
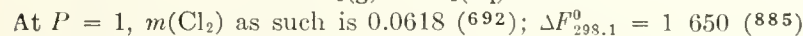
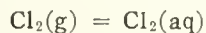
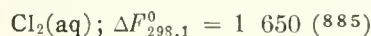
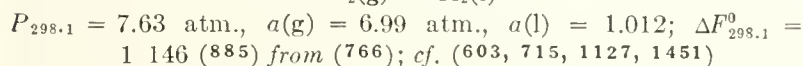
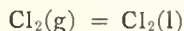
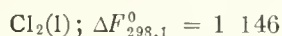
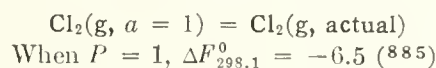
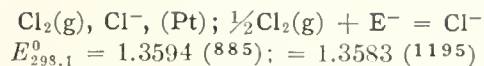
$$\Delta F_{298.1}^0 = -31\,367 \text{ (885)}, \text{ revised value } -31\,345 \text{ (1195)}$$



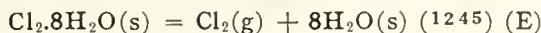
$$\Delta F^0, \Delta H^0 = 0; C_p = 7.4 + 0.001T \text{ (885)}; \text{cf. (1546)}$$



$$\Delta F^0 = 35\,000 - 1.3T \ln T + 0.00025T^2 - 1.5T; \Delta F_{298.1}^0 = 32\,400 \text{ (885)} \text{ from (1137)}; \text{cf. (600, 601, 1138, 1450, 1452, 1505, 1546)}$$

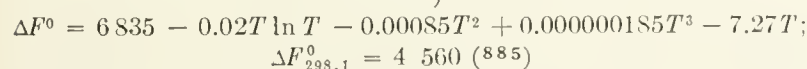
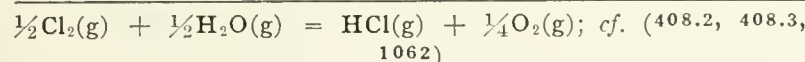
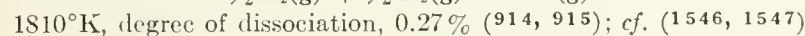
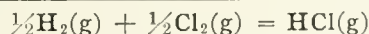
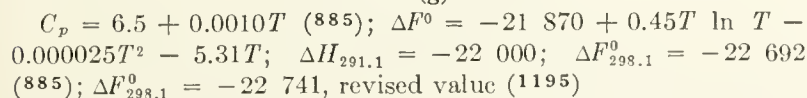
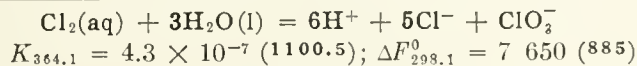
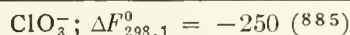
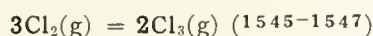


T	P	T	P
270.1	0.241	279.1	0.653
271.1	0.263	281.1	0.816
272.1	0.293	282.1	0.922
272.86	0.321	283.1	1.048
273.1	0.331	285.1	1.301
275.1	0.421	287.1	1.632
277.1	0.524	289.1	2.003

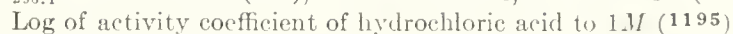
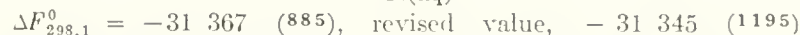
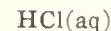


T	P	T	P
263.1	0.205	270.1	0.280
265.1	0.222	271.1	0.293
267.1	0.243	272.1	0.308
269.1	0.267	272.86	0.321*

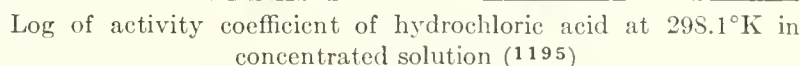
* Quadruple point, hydrate, ice, saturated solution, vapor. For the quadruple point, hydrate, solution of H_2O in Cl_2 , solution of Cl_2 in H_2O , vapor, Roozeboom (1245) finds $T = 301.8$, in good agreement with Isambert (668).



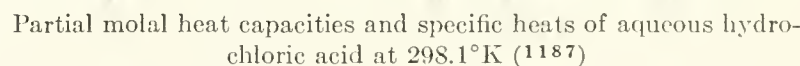
T	$\log K$	I	Lit.
625	-0.608	-7.56	(855)
659	-0.475	-7.59	
692	-0.380	-7.51	
723	-0.353	-7.20	(408.1)
873	-0.001	-7.09	
923	+0.100	-7.11	
703	-0.403	-7.24	(920)
753	-0.335	-6.88	



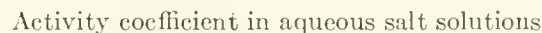
m	$\log \gamma \text{ (298.1}^\circ\text{)}$	$a_1 \text{ (298.1}^\circ\text{)}$
0.001	-0.0153	0.999965
.002	-.0211	.999928
.005	-.0322	.999825
.01	-.0438	.999650
.02	-.0585	.999310
.05	-.0812	.998295
.1	-.0993	.99660
.2	-.1156	.99321
.3	-.1213	.98975
.4	-.1227	.98623
.5	-.1210	.98262
.6	-.1171	.97891
.7	-.1118	.97509
.8	-.1058	.97124
.9	-.0987	.96726
1.0	-.0915	.96324



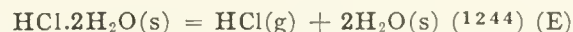
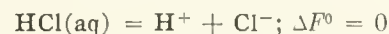
m	$\log \gamma \text{ (298.1}^\circ\text{)}$	$a_1 \text{ (298.1}^\circ\text{)}$	m	$\log \gamma \text{ (298.1}^\circ\text{)}$	$a_1 \text{ (298.1}^\circ\text{)}$
1.2	-0.0743	0.95482	5	0.3757	0.73890
1.4	-.0556	.94605	6	.5078	.67106
1.6	-.0359	.93696	7	.6403	.6027
1.8	-.0153	.92753	8	.7705	.5361
2.0	+ .0080	.91750	9	.9000	.4720
2.5	.0610	.89224	10	1.0189	.4146
3.0	.1205	.86452	12	1.2367	.3162
3.5	.1818	.83515	14	1.4368	.2371
4	.2460	.80401	16	1.6276	.1740



m	\bar{O}_{p1}	\bar{C}_{p2}	Sp. heat
0.00	17.977	-41	0.9979
.05	17.976	-37.8	.9939
.1	17.974	-36.5	.9903
.2	17.969	-34.6	.9830
.5	17.947	-31.0	.9631
1.0	17.893	-27.0	.932

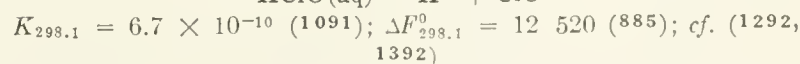
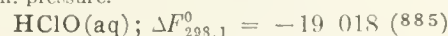


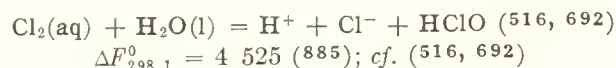
Salt.....	LaCl ₃	BaCl ₂	LiCl	NaCl
Lit.....	(1172)	(1172)	(527, 578, 580)	(527, 578, 580)
Salt.....	KCl			CsCl
Lit.....	(279, 527, 577, 578, 580, 908)			(527)



T	P	T	P
249.7	0.255	254.5	0.896
251.3	0.361	254.9	1.039
252.6	0.495	255.05	1.175
253.05	0.551	255.27	1.302
253.9	0.703	255.4*	1.421
254.3	0.826		

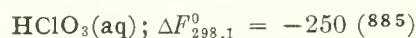
* Melts at atm. pressure.



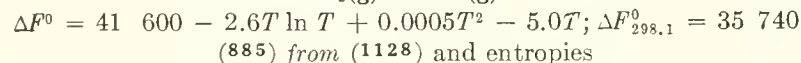
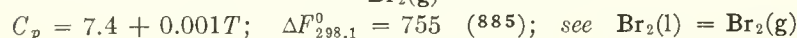
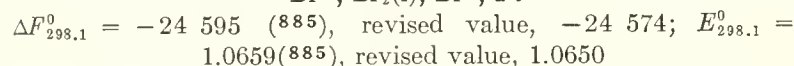
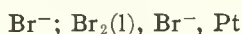
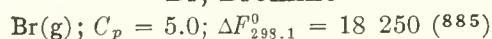


T	$K \times 10^4$	T	$K \times 10^4$
273.1	1.45	303.1	5.65
278.1	1.96	303.1*	6.24
283.1	2.58	308.1	6.43
288.1	3.28	313.1	7.15
288.1*	3.22	318.1	7.84
293.1	4.06	323.1	8.51
298.1	4.84	328.1	9.12
298.1*	4.66	333.1	9.75

* From (516) recalculated by (692); all other values from (692).

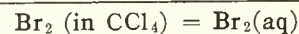
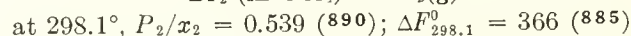
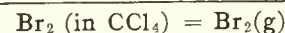
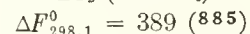
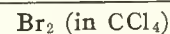
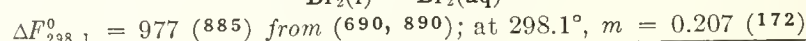
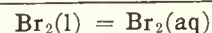
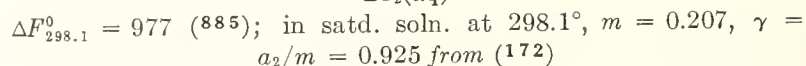
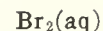
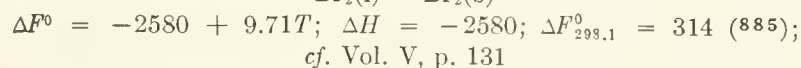
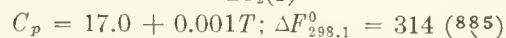
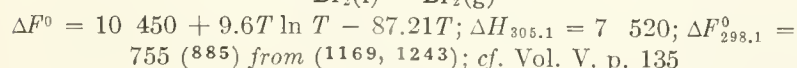
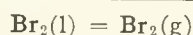
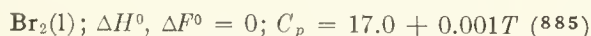


Br, Bromine

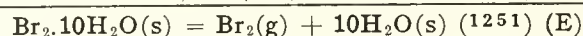


T	$\log K$	ΔH	Lit.*
923	-5.983		(334)
1 000	-5.267		
1 051	-4.944	41 200	
1 073	-3.747		(1128)
1 075.7	-3.775		(131)
1 123	-3.395		(1128)
1 130	-4.296		(334)
1 173	-2.854	42 100	(1128)
1 173	-3.982		(334)
1 176.7	-3.119		(131)
1 223	-2.484	41 900	(1128)
1 273	-2.114	41 500	
1 275.6	-2.376		(131)
1 299.1	-2.222		
1 323	-1.740	41 000	(1128)
1 326.1	-2.093		(131)
1 333.8	-1.999		
1 352.4	-1.871		
1 396.6	-1.623		
1 408.6	-1.585		
1 443.2	-1.408		
1 477.9	-1.244		
1 483.4	-1.209		
1 555.8	-0.885		
1 557.8	-0.876		

* See also (166, 600, 601, 603, 675, 1545-1547).

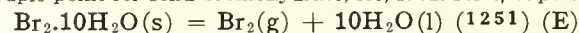


x_2	0.14	0.0	$\Delta F_{298.1}^0$
m/x_2	0.35	0.371	588
Lit.....	(690)	(890)	(885)



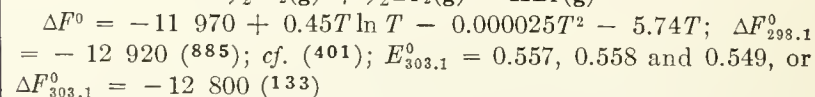
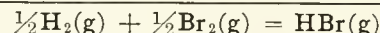
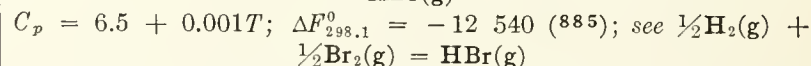
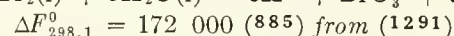
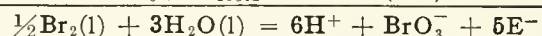
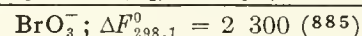
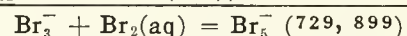
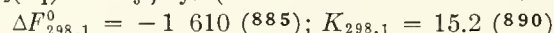
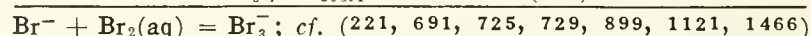
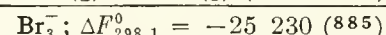
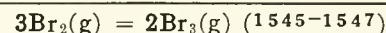
T	P	$p_{\text{H}_2\text{O}}$	p_{Br_2}
263.1	0.033	0.00262	0.030
265.1	.037	.00313	.0337
267.1	.041	.00371	.0371
269.1	.046	.00439	.0417
271.1	.051	.00516	.0461
272.1	.054		
272.8	.057*		

* Quadruple point for solid bromohydrate, ice, satd. soln., vapor.

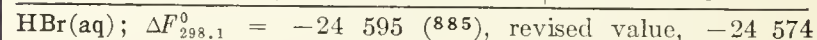


T	p_{Br_2}	T	p_{Br_2}
273.5	0.0664	278.1	0.106
275.1	.075	278.6	.112
276.1	.0836	279.0	.118
277.2	.096	279.3	.122*

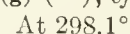
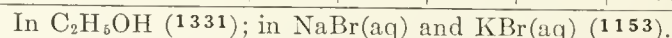
* Quadruple point for solid bromohydrate, liq. H_2O , liq. Br_2 , vapor. According to (1472, 1473) at the quadruple point the pressure is 1 atm. at $T = 279.9^\circ$; in oxygen, 150 atm. at $T = 293.1^\circ$.



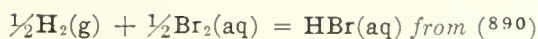
$T \text{ (408.2)}$	$\log K$	I
1 297.1	2.60	-5.87
1 381.1	2.44	-5.72
1 495.1	2.27	-5.64



m	6.0	7.0	8.0	9.0	10.0	11.0
γ	6.14	8.23	11.2	15.8	23.0	33.4

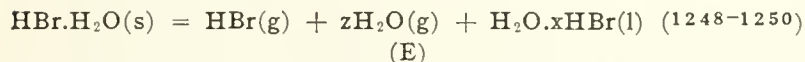


m	$P \times 10^4$	m	$P \times 10^4$
6	0.01987	9	0.2974
7	0.04868	10	0.7763
8	0.1171	11	1.987



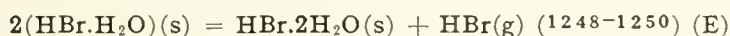
log [H ⁺]	log [Br ⁻]	log [Br ₂ (aq.)]	E _{298.1}	log γ + const.*	μ _{1/2}
-2.0000	-2.0334	-2.3062	1.2623	-9.2302	0.1000
-2.0000	-2.0123	-2.7416	1.2476	-9.2254	.1000
-2.0000	-2.0092	-2.8671	1.2442	-9.2295	.1000
-1.5229	-1.5591	-2.2716	1.2093	-9.2492	.1732
-1.5229	-1.5391	-2.6273	1.1976	-9.2492	.1732
-1.5229	-1.5302	-3.0259	1.1852	-9.2485	.1732
-1.0000	-1.0825	-1.8891	1.1648	-9.2772	.3162
-1.0000	-1.0635	-2.0123	1.1600	-9.2769	.3162
-1.0000	-1.0283	-2.3778	1.1471	-9.2768	.3162
-1.0000	-1.0092	-2.8827	1.1312	-9.2782	.3162

* Constant = -9.1883.

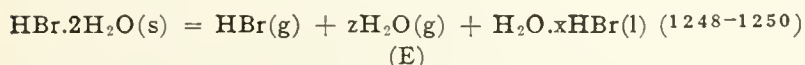


T	P	T	P
257.5	2.5	265.9	6.0
258.3	2.75	267.3	7.0
259.1	3.0	268.4	8.0
262.1	4.0	269.1	9.0
264.4	5.0	269.8	10.5*

* Appearance of liquid HBr.

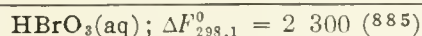
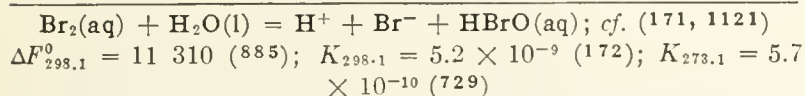
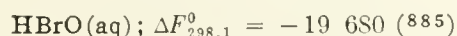


T	P	T	P
244.6	0.100	253.1	0.172
247.1	.112	255.1	.205
249.1	.126	257.1	.242
251.1	.146	257.6	.257*

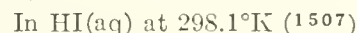
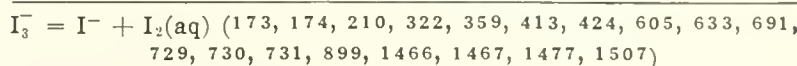
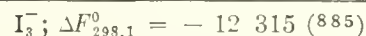
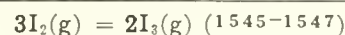
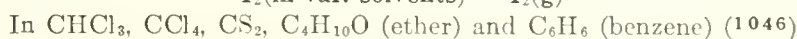
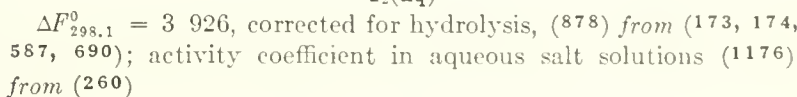
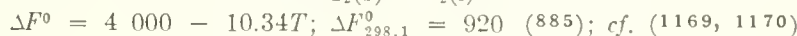
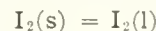
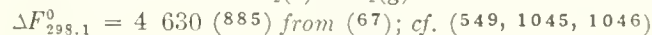
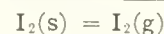
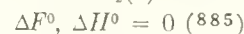
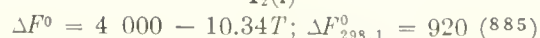
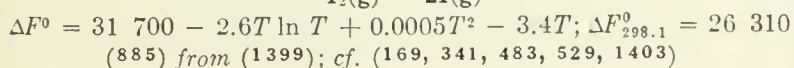
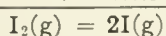
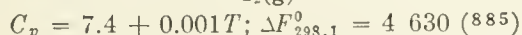
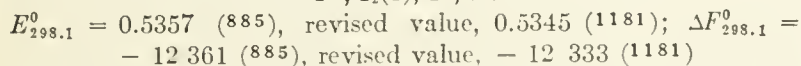
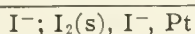
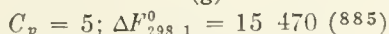
* Appearance of solution of HBr in H₂O.

T	P	T	P
The solution contains less HBr than the hydrate			
248.1	0.0013	260.1	0.289
251.3	.013	260.7	.368
254.2	.039	261.1	.447
256.3	.079	261.5	.579
258.5	.158	261.8	.691*
The solution contains more HBr than the hydrate			
257.6	2.5	260.5	1.5
258.3	2.25	261.1	1.25
259.1	2.00	261.5	1.00
259.8	1.75		

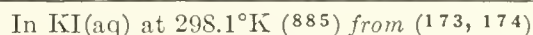
* M. P.; hydrate and solution contain equal amounts of HBr.



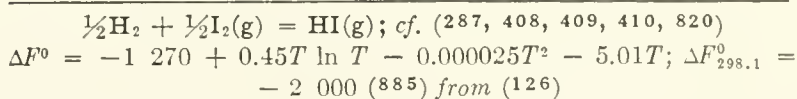
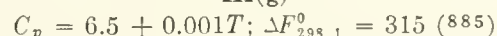
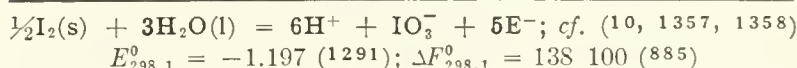
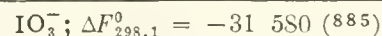
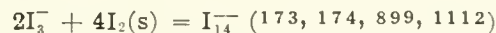
I, Iodine



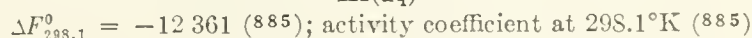
c(ΣHI)	c(ΣHI ₃)	c(I ₂)	10 ³ K _c
0.05715	0.000904	0.0000202	1.30 + a.d.
to	to	to	= 0.015
0.0801	.0821	.00132	



μ	[KI]/[KI ₃]	μ	[KI]/[KI ₃]
0.001	1.14	0.010	1.06
.002	1.11	.020	1.04
.005	1.08	.100	0.99



T	ln K	I
553	2.2229	-4.94
633	2.0984	-5.05
713	1.9631	-5.06
793	1.8219	-5.00
T (1401)	ΔF ⁰	I
304.7	-2 036	-5.0
328.3	-2 019	-4.8
354.7	-1 958	-4.5



m	6	7	8	9	10
γ	6.35	9.71	16.1	30.5	57.9



m	P _{HI} × 10 ⁴ (298.1°K)	m	P _{HI} × 10 ⁴ (298.1°K)
6	0.00750	9	0.3882
7	.02395	10	1.737
8	.08555		

$\text{HIO}(\text{aq}); \Delta F_{298.1}^0 = -23\ 170\ (885)$			
$\text{HIO}(\text{aq}) = \text{H}^+ + \text{IO}^-; K = ca. 10^{-11}\ (460)$			
$\text{I}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) = \text{H}^+ + \text{I}^- + \text{HIO}(\text{aq})$			
$K_{298.1} = 3 \times 10^{-13}\ (171, 172); \text{cf. } (1040, 1355, 1356); \Delta F_{298.1}^0 = 17\ 100\ (885)$			

$2\text{HIO}_3(\text{s}) = \text{I}_2\text{O}_5(\text{s}) + \text{H}_2\text{O}(\text{g})\ (338, 844)\ (\text{E})$			
T	P	T	P
293.1	0.001	351.6	0.217
313.1	0.012	358.1*	0.386
342.1	0.150	373.1	0.692

* From (338); all other values from (844).

$\text{HIO}_3(\text{aq}); \Delta F_{298.1}^0 = -31\ 580\ (885)$			
$\text{ICl}_3\ (493)$			

S, Sulfur

S(g)

$$C_p = 5; \Delta F_{298.1}^0 = 30\ 240\ (885)$$

S₂(g)

$$C_p = 6.5 + 0.001T\ (885); \Delta F_{718.1}^0 = 3\ 320; \Delta F_{298.1}^0 = 18\ 280; \Delta H_{298.1} = 29\ 690; \Delta F^0 = 30\ 580 + 1.74T \ln T + 0.0042T^2 - 52.4T\ (879, 885)\ \text{from } (124, 1159, 1160)$$

$$\text{S}_2(\text{g}) = 2\text{S}(\text{g}); \text{cf. } (117, 217)$$

$$\Delta F^0 = 46\ 700 - 3.5T \ln T + 0.0005T^2 + 4.6T; \Delta F_{2200}^0 = 0\ (1052); \Delta F_{298.1}^0 = 42\ 200\ (885)$$

S₈(g)

$$\Delta F^0 = 22\ 600 - 35.9T; \Delta F_{298.1}^0 = 11\ 900\ (885)$$

S₈(l)

$$\Delta F^0 = 20\ 000 - 33.6T; \Delta F_{298.1}^0 = 10\ 000\ (885)$$

S (rhomb) = S (equilib. vapor) and $\text{S}_{\lambda, \mu}(\text{l}) = \text{S}$ (equilib. vapor); see Vol. III, p. 201

Pt, S²⁻, S (rhomb)

$$E_{298.1}^0 = 0.51\ (885)$$

S_λ(l)

$$C_p = 5.4 + 0.005T\ (885)\ \text{from } (875); \Delta F_{298.1}^0 = 94\ (885)$$

S (rhomb) = S_λ(l)

$$\Delta H_{373.1} = 467\ (875); \text{M. P.} = 112.8^\circ\text{C}\ (779, 1373); \Delta F^0 = -35 - 1.28T \ln T - 0.00015T^2 + 7.77T\ (885)$$

$$\text{S}_{\lambda} = \text{S}_{\mu}; \Delta H = 416\ (875)$$

$$\text{S}_{\lambda, \mu}(\text{l}); \Delta F_{298.1}^0 = 93\ (885)$$

2S_{λ, μ}(l) = S₂(g)

$$\Delta F_{623.1}^0 = 7\ 710; \Delta F_{718.1}^0 = 4\ 660; \Delta F_{723.1}^0 = 4\ 590\ (879, 885)\ \text{from } (124, 1159, 1160)$$

$$\text{S}_{\lambda}(\text{l}) = \text{S}_{\lambda, \mu}(\text{l})\ (879, 885)\ \text{from } (259, 875, 1375); \Delta F_{383.5}^0 = -2.7\ \text{from S (rhomb)} = \text{S}_{\lambda, \mu}(\text{l})$$

T	y^*	$\int_{298}^T -\frac{416y}{T^2} dt$	ΔF^0
298	0.008	0.0	-0.8
373	.031	-0.00465	-2.5
393	.040	-0.00664	-3.4
413	.055	-0.00902	-4.5
423	.067	-0.01037	-5.2
433	.111	-0.01217	-6.1
443	.187	-0.01553	-7.7
453	.225	-0.01981	-9.8
473	.270	-0.0295	-14.8
510	.313	-0.0496	-26.1
573	.332	-0.0771	-45.0
653	.338	-0.1070	-70.9
718	.341	-0.1267	-91.8

* y = mole fraction of S_{μ} in $\text{S}_{\lambda, \mu}$.

$6\text{S}_{\lambda, \mu}(\text{l}) = \text{S}_6(\text{g})$	
$\Delta F_{718.1}^0 = 860\ (885)\ \text{from } (1159, 1160)$	
$8\text{S}_{\lambda, \mu}(\text{l}) = \text{S}_8(\text{g})$	
$\Delta F_{718.1}^0 = 1\ 250\ (885)\ \text{from } (1159, 1160)$	
$\text{S (monocl)}; C_p = 3.62 + 0.0072T\ (885)$	
$\text{S (monocl)} = \text{S}_{\lambda}(\text{l})$	
$\Delta F_{392.1}^0 = 0\ (1374, 1526); \Delta F^0 = -155 - 1.78T \ln T + 0.0011T^2 + 10.60T\ (879, 885)$	

S (rhomb)

$$\Delta F^0, \Delta H^0 = 0; C_p = 4.12 + 0.0047T\ (885)$$

S (rhomb) = S (monocl) (189)

$$\Delta F^0 = 120 + 0.50T \ln T - 0.00125T^2 - 2.820T; \Delta F_{298.1}^0 = 17.5\ (879, 885); \Delta F_{368.1}^0 = 0; \Delta H_{273.1} = 77.0; \Delta F_{298.1}^0 = 18.3\ (879, 885)$$

T	Solvent	s (rhomb)*	s (monocl)*	Ratio
273.1	Chloroform.....	11.01	7.88	1.40
	Ethyl bromide.....	8.52	6.11	1.40
	Ethyl ether.....	1.13	0.80	1.41
	Ethyl formate.....	0.28	0.19	1.4
288.6	Chloroform.....	16.58	12.53	1.33
291.7	Benzene.....	20.04	15.12	1.32
298.4	Benzene.....	23.35	18.35	1.27
	Ethyl alcohol.....	0.66	0.52	1.3
	Ethyl bromide.....	16.76	13.07	1.28
	Ethyl ether.....	2.56	2.00	1.28
313.1	Chloroform.....	29	0.24	1.2

* s is the solubility in grams/liter of soln.

$$\text{S}^{2-}; \Delta F_{298.1}^0 = 23\ 450\ (885)$$

SO₂(g)

$$C_p = 7.0 + 0.0071T - 0.00000186T^2; \Delta F_{298.1}^0 = -69\ 660\ (885); \text{cf. } (886, 1052)$$

$$\text{SO}_2(\text{aq}); \Delta F_{298.1}^0 = -69\ 770\ (885)$$

SO₂(aq) = SO₂(g)

$$\Delta F_{298.1}^0 = 110\ (885)\ \text{from } (894); \text{cf. } (1347); \text{in } \text{H}_2\text{SO}_4(\text{aq})\ (357, 358)$$

SO₂·7H₂O(?) = SO₂(g) + 7H₂O(s) (1246) (E)

T	P	T	P
264.1	0.197	269.1	0.2545
265.1	0.211	270.1	0.2716
267.1	0.233	270.5	0.2785*

* Quadruple point, hydrate, ice, soln., vapor.

$$\text{SO}_2 \cdot 7\text{H}_2\text{O}(\text{?}) = \text{SO}_2(\text{g}) + 7\text{H}_2\text{O}(\text{l})\ (1246); \text{cf. } (1472, 1473)\ (\text{E})$$

T	P	T	P
267.1	0.180	275.9	0.568
269.1	0.2321	277.55	0.683
270.1	0.264	279.1	0.876
270.5	0.2785	281.5	1.218
271.1	0.303	283.1	1.548
272.1	0.345	284.4	1.977
273.1	0.391	284.85	2.191
273.23	0.395	285.15	2.311*

* Quadruple point, hydrate, satd. soln. of SO₂ in H₂O, satd. soln. of H₂O in SO₂, vapor.

$$\text{SO}_3(\text{g}); \Delta F_{298.1}^0 = -85\ 890\ (885)$$

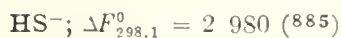
SO₂(g) + 1/2 O₂(g) = SO₃(g)

$$\Delta F^0 = -22\ 600 + 21.36T; \Delta F_{298.1}^0 = -16\ 230\ (885)\ \text{from } (136)$$

T	$\log K$	I	T	$\log K$	I
801	1.496	21.35	1000	0.268	21.37
852	1.141	21.31	1062	-0.020	21.38
900	0.816	21.37	1105	-0.202	21.37
953	0.510	21.38	1170	-0.446	21.36

$$\text{SO}_3^{2-}; \Delta F_{298.1}^0 = -116\ 680\ (885)$$

$$\text{SO}_4^{2-}; \Delta F_{298.1}^0 = -176\ 500\ (885)$$



$$K_{298.1} = 10^{-15}; \Delta F_{298.1}^0 = 20\,470 \text{ (885) from (768); cf. (177, 699, 1506)}$$

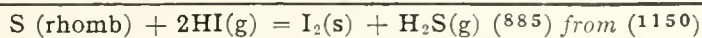


$$C_p = 8.81 - 0.0019T + 0.00000222T^2; \Delta F_{298.1}^0 = -7\,840 \text{ (885)}$$



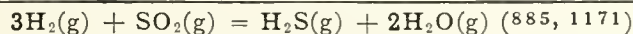
$$\Delta F^0 = -19\,200 + 0.94T \ln T + 0.00165T^2 - 0.00000037T^3 + 1.65T; \Delta F_{298.1}^0 = -16\,980 \text{ (885)}$$

T	$\log K$	I	Lit.
1 023	2.025	1.68	(1160)
1 103	1.710	1.63	
1 218	1.305	1.64	
1 338	0.964	1.63	
1 362	.902	1.63	(1171)
1 405	.793	1.64	(1160)
1 473	.643	1.61	(1171)
1 537	.490	1.69	
1 667	.257	1.69	



$$\Delta F^0 = -17\,880 - 4.89T \ln T + 0.0043T^2 - 0.00000037T^3 + 58.31T; \Delta F_{298.1}^0 = -8\,470$$

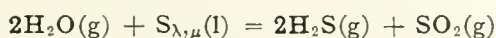
T	$\log K$	I
313.2	5.595	58.27
323.2	5.223	58.32
333.2	4.878	58.33



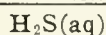
$$\Delta F^0 = -50\,760 + 0.07T \ln T + 0.00775T^2 - 0.00000142T^3 + 9.35T$$

T	$\log K_{\text{cor.}}^*$	I
1 160	5.93	9.03
1 362	4.33	9.02
1 473	3.57	9.27
1 473	3.50	9.59
1 645	2.53	9.85

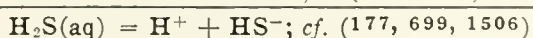
* $\log K$ corrected for $\text{S}_2(\text{g}) = 2\text{S}$.



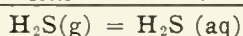
$$K_{718.1} = 0.00154; \Delta F_{718.1}^0 = 9\,240 \text{ (882)}$$



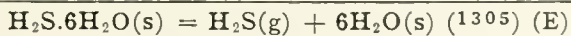
$$\Delta F_{298.1}^0 = -6\,490 \text{ (885); for activity coefficient in aqueous salt solutions at } 298.1^\circ\text{K, v. (977, 1175)}$$



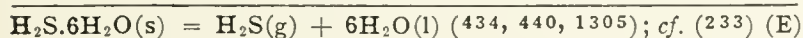
$$K_{291.1} = 0.91 \times 10^{-7} \text{ (34); } K_{298.1} = 1.15 \times 10^{-7}; \Delta H = 6\,000; \Delta F_{298.1}^0 = 9\,470 \text{ (885)}$$



$$\Delta F_{298.1}^0 = 1\,350 \text{ (885) from (754.5, 1532); } = 1\,363 \text{ (977)}$$



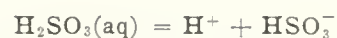
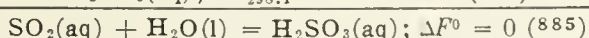
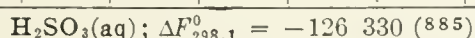
$$\log P_{\text{mm}} = -\frac{1333}{T} + 3.8585 \text{ (range } -26 \text{ to } -1^\circ\text{C); } \Delta H = 5\,550$$



The $\frac{1}{T}$ vs. $\log P$ graph is linear between $P_{273.1} = 0.974$ and $P_{282.1} = 2.5$ atm. and between $P_{282.1} = 2.5$ and $P_{301.6} = 16$ atm. Critical decomposition at 29°C and 23 atm. (233); $P = 50$ atm. at 30°C ; $\Delta H = 14\,270$.

Partial pressures (interpolated)

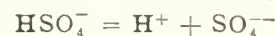
$T, ^\circ\text{K} \dots \dots \dots$	274.0	275.0	276.0	277.0	278.0	280.0	282.0
$10^3 P_{\text{atm.}}$ $\left. \begin{array}{l} \text{H}_2\text{O} \\ \text{H}_2\text{S} \end{array} \right\}$	7	7.2	7.2	7.9	8.6	9.9	11.2
	1 092	1 221	1 329	1 485	1 611	1 971	2 408



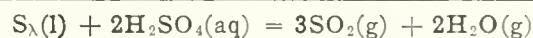
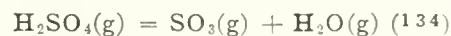
$$K_{298.1} = 0.017; \Delta F_{298.1}^0 = 2\,410 \text{ from (355, 698, 778, 779, 976)}$$



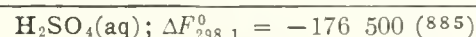
$$K_{298.1} = 5 \times 10^{-6} \text{ (698); } \Delta F_{298.1}^0 = 7\,240 \text{ (885)}$$



$$\Delta F^0 = 0 \text{ (885); however, } K_{298.1} = 3 \times 10^2 \text{ (1088); } = 2 \times 10^2 \text{ (783, 784); see also (356, 384.5, 1444)}$$



$$\Delta F^0 = 91\,205 - 12.8T \ln T - 0.00625T^2 + 0.00000019T^3 + 124.6T; \Delta F_{298.1}^0 = 31\,500 \text{ (88)}$$



m	$\gamma_{298.1}$	m	$\gamma_{298.1}$
0.01	0.617	2	0.147
.02	.519	3	.166
.05	.397	4	.203
.1	.313	5	.242
.2	.244	10	.660
.5	.178	15	1.26
1	.150	20	2.22

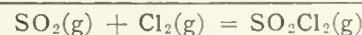
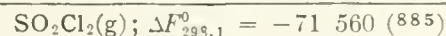
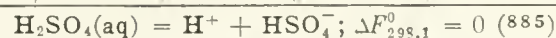
Partial molal heat capacities at *ca.* 288°K (885) from (112); cf. (348)

x_2	\bar{C}_{p1}	\bar{C}_{p2}	x_2	\bar{C}_{p1}	\bar{C}_{p2}
0.00	18.02	10.4	0.30	13.78	34.3
.01	17.98	14.7	.35	12.02	38.1
.02	17.87	21.8	.40	10.45	40.7
.04	17.75	26.8	.50	15	35
.06	17.96	23.0	.60	21.6	29.8
.08	18.31	17.1	.70	19.7	30.6
.10	18.61	14.7	.80	16.2	31.9
.15	17.80	19.9	.90	11.7	32.7
.20	16.68	25.3	1.00	8.1	33.0
.25	15.33	30.1			

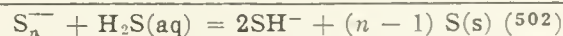
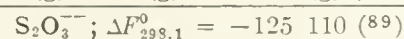
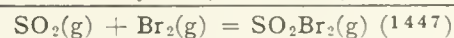
For activity coefficient in $\text{ZnSO}_4(\text{aq})$ at 298.1°K , v. (30, 1184). For activity coefficient in $\text{Na}_2\text{SO}_4(\text{aq})$ at 298.1°K , v. (11, 580, 583, 1184); $E_{298.1}^0 = 0.6241$.

Partial molal heat content at *ca.* 298°K (885) from (192)

x_2	\bar{L}_1	\bar{L}_2	x_2	\bar{L}_1	\bar{L}_2
0.00	0.0	0	0.55	-5 730	19 040
.05	-43.7	4 130	.60	-6 300	19 530
.10	-293.3	7 730	.65	-6 690	19 740
.15	-580	9 310	.70	-7 010	19 910
.20	-1 000	11 190	.75	-7 280	20 027
.25	-1 450	12 680	.80	-7 490	20 098
.30	-1 910	13 970	.85	-7 700	20 136
.35	-2 470	15 130	.90	-7 870	20 153
.40	-3 060	16 160	.95	-8 050	20 172
.45	-3 880	17 240	1.00	-8 220	20 200
.50	-4 850	18 310			



$$\Delta F^0 = -11\,150 + 31T \text{ (range } 383 \text{ to } 411^\circ\text{K); } \Delta F_{298.1}^0 = -1\,900 \text{ from (1445, 1447)}$$



With Na^+ , $m = 0.0995$ to 0.303 at 298.1°K , $K(n=2) = 17.9$ to 25.1 ; $K(n=4) = 64.8$ to 85.9

Se, Selenium

Se (hexagonal); ΔF^0 , $\Delta H^0 = 0$

Se (hexagonal) = Se (g, equilib.) (345)

Se(l) = Se (g, equilib.) (345, 841, 1158)

 $\text{Se}_6 = 3\text{Se}_2(\text{g})$ (1158); cf. (1498)

Gas assumed to obey perfect gas law

T	K	T	K
823.1	9.2×10^{-7}	973.1	2.51×10^{-4}
873.1	7.41×10^{-6}	1 023.1	1.16×10^{-4}
923.1	4.78×10^{-5}	1 073.1	4.78×10^{-3}

 $\text{HSeO}_3^- = \text{H}^+ + \text{SeO}_3^{--}$; $K_{298.1} = 0.87 \times 10^{-8}$ (1529) $2\text{H}_2\text{Se}(\text{g}) = 2\text{H}_2(\text{g}) + \text{Se}_2(\text{g})$ (1158); cf. (1122) $\text{H}_2(\text{g})$ and $\text{H}_2\text{Se}(\text{g})$ assumed perfect gases; P_{Se_2} calculated from K for $\text{Se}_6 = 3\text{Se}_2$

T	873.1	923.1	1023.1
K	8.4×10^{-8}	3.42×10^{-7}	1.14×10^{-6}

 $\text{H}_2\text{Se}(\text{aq}) = \text{H}^+ + \text{HSe}^-$; $K_{298.1} = 1.7 \times 10^{-4}$ (215) $\text{H}_2\text{Se}(\text{g}) = \text{H}_2\text{Se}(\text{aq})$ (972) $P_{\text{H}_2\text{Se}} = 1$ (972); $\Delta H_{298.1} = -2 431$ (437, 438); $\Delta F_{298.1}^0 = 1 467$ (972)

T	$c(\text{H}_2\text{Se}, \text{aq})$	T	$c(\text{H}_2\text{Se}, \text{aq})$
287.7	0.09789	298.7	0.08277
288.1	.09611	308.1	.07317
298.1	.08415		

In $\text{HI}(\text{aq})$ at 298.1°K (972). $\text{H}_2\text{Se} \cdot x\text{H}_2\text{O} (?) = \text{H}_2\text{Se}(\text{g}) + x\text{H}_2\text{O} (?)$ (437, 438) (E)

T	P	T	P
273.1	0.455	281.1	1.00
275.45	.568	287.2	1.9
276.5	.645	295.1	5.0
278.5	.786	303.1*	11.0
280.6	.945		$\Delta H = 16 820\text{x}$

* Critical decomposition temperature.

 $\text{H}_2\text{SeO}_3(\text{s}) = \text{SeO}_2(\text{s}) + \text{H}_2\text{O}(\text{g})$ (947, 992)

T	P	T	P
294.1	0.0013	335.1	0.0332
297.1	.0021	345.4	.0561
305.1	.0042	348.1	.0651
314.1	.0078	353.1	.0787
316.1	.0097	364.2	.1261
318.1	.0107	378.1	.1966
321.1	.0142	384.1	.2419
322.1	.0153		

 $\text{SeO}_2 \cdot 4\text{HCl}(\text{s}) = \text{SeO}_2(\text{s}) + 4\text{HCl}(\text{g})$ $P = 1$ atm. at 379°K (339, 340) $\text{SeO}_2 \cdot 4\text{HBr}(\text{s}) = \text{SeO}_2(\text{s}) + 4\text{HBr}(\text{g})$ $P = 1$ atm. at 328°K (339, 340) $\text{H}_2\text{Se}(\text{g}) + \text{I}_2(\text{s}) = 2\text{HI}(\text{g}) + \text{Se}(\text{amorp})$ (1240)

T	273.1	290.0	300.0	ΔH
K	33.68	22.62	18.06	3 954

 $\text{H}_2\text{SeO}_3(\text{aq}) = \text{H}^+ + \text{HSeO}_3^-$ $K_{298.1} = 3.45 \times 10^{-3}$ (1259); $K_{298.1} = 4.0 \times 10^{-5}$ (1529)

Te, Tellurium

Te(s); ΔF^0 , $\Delta H^0 = 0$

Te(g, equilib.) (90, 357, 1287, 1288, 1498)

 $\text{Te}(\text{s}) + 2\text{E}^- = \text{Te}^{--}$; (Te(s), Te^{--}) $E_{292-293}^0 = -0.894$ (749) $\text{Te}(\text{s}) = \text{Te}^{++++} + 4\text{E}^-$; (Te(s), Te^{++++}) $E_{292-293}^0 = -0.549$; (Te^{++++}) = 0.25m (748, 749); $E_{292-293}^0 = -0.558$ (1200) $5\text{Te} = 2\text{Te}_2^{--} + \text{Te}^{++++}$ $K_{\text{room}} = 10^{-95}$ (747, 748, 749) $\text{TeO}_2(\text{s}) + 4\text{H}^+ = \text{Te}^{++++} + 2\text{H}_2\text{O}(\text{l})$ In $\text{HCl}(\text{aq})$ at 291.1°K (750)

$c(\text{HCl})$	$c(\text{Te}^{++++})$	$c(\text{HCl})^*$	$c(\text{Te}^{++++})^*$	K^*
0.10	0.00057	0.22	0.000039	0.026
.22	.0012	.458	.00039	.016
.46	.0037	.73	.0029	.022
.92	.0091	.914	.0060	.021
				Mean = 0.021

* By emf method (750).

 $2\text{Te}(\text{s}) + 2\text{E}^- = \text{Te}_2^{--}$; (Te(s), Te_2^{--}) $E_{292-293} = -0.818$; $\text{Te}_2^{--} = 0.5m$; $E_{292-293}^0 = -0.836$ (748, 749); $E_{292-293}^0 = -0.827$; $\text{Te}_2^{--} = 0.5m$ (1200) $\text{Te}_2^{--} = \text{Te}^{--} + \text{Te}(\text{s})$; $K_{292} < 10^{-2}$ (749) $\text{TeO}_3^- + 3\text{H}_2\text{O}(\text{l}) = \text{Te}^{++++} + 6\text{OH}^-$ $K_{292-293} = 1.7 \times 10^{-47}$ (748, 749, 1200) $\text{HTeO}_3^- = \text{H}^+ + \text{TeO}_3^{--}$ $K_{298.1} = 10^{-8}$ (122); $= 10^{-9.87}$ (325) $\text{HTeO}_4^- = \text{H}^+ + \text{TeO}_4^{--}$; $K_{298.1} = 4 \times 10^{-11}$ (122) $\text{H}_2\text{Te}(\text{aq}) = \text{H}^+ + \text{HTe}^-$; $K_{298.1} = 10^{-2}$ (215) $\text{H}_2\text{TeO}_3(\text{s}) + 4\text{H}^+ = \text{Te}^{++++} + 3\text{H}_2\text{O}(\text{l})$ In $\text{HCl}(\text{aq})$ at 291.1°K (750) by emf method

$c(\text{Cl}^-)$	$c(\text{Te}^{++++})$	K_c
0.0	0.2×10^{-19}	
.001	$.49 \times 10^{-9}$	510
.005	$.78 \times 10^{-7}$	140
.01	$.14 \times 10^{-5}$	190
		Mean = 300

 $\text{TeO}_2(\text{s}) + \text{H}_2\text{O}(\text{l}) = \text{H}_2\text{TeO}_3(\text{s})$ $\Delta F_{291.1}^0 = -5 550 \pm 500$ (750) $\text{H}_2\text{TeO}_3(\text{aq}) = \text{H}^+ + \text{HTeO}_3^-$ $K_{298.1} = 2 \times 10^{-3}$ (122); $= 0.6 \times 10^{-5}$ (325) $\text{H}_2\text{TeO}_4(\text{aq}) = \text{H}^+ + \text{HTeO}_4^-$ $K_{298.1} = 6 \times 10^{-7}$ (122)

N, Nitrogen

 $\text{N}_2(\text{g})$ ΔF^0 , $\Delta H^0 = 0$; $C_p = 6.5 + 0.001T$ (885) $\text{N}_2(\text{g}) = 2\text{N}(\text{g})$; v . Vol. V, p. 418 $\text{N}_2(\text{aq})$ $\Delta F_{298.1}^0 = 4 358$ (468); for activity coefficient in aqueous salt solutions at 298.1°K, v . (468, 1175) $\text{NO}(\text{g})$ $C_p = 6.5 + 0.001T$ (885); $\Delta F_{298.1}^0 = 20 869$, revised value (1193) $\frac{1}{2}\text{N}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) = \text{NO}(\text{g})$ $\Delta F^0 = 21 600 - 2.50T$; $\Delta F_{298.1}^0 = 20 850$ (885). $\Delta F^0 = 21 605 - 2.470T$; $\Delta H_{298.1}^0 = 21 605$; $\Delta F_{298.1}^0 = 20 869$, revised values (1193) from (419, 697, 1053, 1054); cf. (110, 509, 550, 551, 1026.5, 1092)

T	$\log K$	I	Lit.
1 811	-2.038	-2.599	(1053, 1054)
1 877	-1.982	-2.434	(697)
2 023	-1.784	-2.509	(697)
2 033	-1.798	-2.395	(1053, 1054)
2 195	-1.609	-2.478	(1053, 1054)
2 580	-1.283	-2.500	(419, 1053, 1054)
2 675	-1.245	-2.376	(419, 1053, 1054)

 $\text{NO}(\text{l})$ $C_p = 17.35$ (402); $\Delta F_{298.1}^0 = 24 594$; $\Delta H_{298.1}^0 = 20 228$ (1193)

NO(l) = NO(g)

$\Delta F^0 = 4\,567 + 10.85T \ln T - 0.0005T^2 - 89.484T$ (range 110 to 125°K); $\Delta F_{298.1}^0 = -3\,725$; $\Delta H_{298.1}^0 = 1\,377$; vapor pressures corrected for fugacity of liquid and vapor (1193) from (501, 602); cf. (481.5)

NO(s)

$C_p = -1.2 + 0.15T - 0.00048T^2$ (40 – 120°K) (1193) from (402); $\Delta F_{298.1}^0 = 26\,398$; $\Delta H_{298.1}^0 = 17\,926$ (1193)

NO(s) = NO(g)

$\Delta F^0 = 3\,765 - 7.7T \ln T + 0.0745T^2 - 0.00008T^3 - 2.407T$ (range 73 to 110°K); $\Delta F_{298.1}^0 = -5\,529$; $\Delta H_{298.1}^0 = 3\,679$; vapor pressures corrected for fugacity of solid and vapor (1193) from (501, 602, 1038); cf. (481.5)

NO₂(g)

$C_p = 7.0 + 0.0071T - 0.00000086T^2$ (885); $\Delta H_{298.1}^0 = 8\,018$; $\Delta F_{298.1}^0 = 11\,920$ (885); = 12 495, revised value (1193)

NO(g) + ½O₂(g) = NO₂(g)

$\Delta F^0 = -14\,170 + 2.75T \ln T - 0.0028T^2 + 0.00000031T^3 + 2.73T$; $\Delta F_{298.1}^0 = -8\,930$ (885). $\Delta F^0 = -13\,000 + 2.75T \ln T - 0.0028T^2 + 0.00000031T^3 + 0.656T$; $\Delta F_{298.1}^0 = -8\,374$; $\Delta H_{298.1}^0 = -13\,587$, revised values (1193) from (130, 134, 1224)

NO₂⁻; $\Delta F_{298.1}^0 = -8\,500$ (885)

NO₃⁻; $\Delta F_{298.1}^0 = -26\,500$ (885)

HNO₂(aq); $\Delta F_{298.1}^0 = -13\,070$ (885)

HNO₂(aq) = H⁺ + NO₂⁻

$K_{298.1} = 0.00045$ (1334); = 0.00056 (337); $\Delta F_{298.1}^0 = 4\,570$ (885)

H⁺ + NO₃⁻ + 2NO(g) + H₂O(l) = 3HNO₂(aq)

$\Delta F_{298.1}^0 = 2040$ (885)

<i>m</i> (HNO ₃)	<i>K</i> _{298.1}	Lit.
0.05	0.032	(1294)
.1	.024	(1294)
.1	.030	(866)
.2	.022	(1294)
.2	.019	(866)

HNO₃(g); $\Delta F_{298.1}^0 = -18\,210$ (885)

2HNO₃(g) = H₂O(g) + 2NO₂(g) + ½O₂(g) (127)

3NO₂(g) + H₂O(g) = NO(g) + 2HNO₃(g) (885) from (223)

<i>T</i>	283.1	298.1	323.1	348.1
ΔF^0	-3 000	-3 190	-3 250	-3 810

HNO₃(aq) (885) from (223)

$\Delta F_{298.1}^0 = -26\,500$ (885)

<i>m</i>	0.05	0.1	0.2	0.5	1
γ	0.83	0.79	0.76	0.73	0.73
<i>m</i>	2	4	9	16	36
γ	0.79	0.92	1.16	1.45	2.18

HNO₃(aq) = H⁺ + NO₃⁻; $\Delta F^0 = 0$ (885)

HNO₃(aq) = HNO₃(g)

$\Delta F^0 = 8\,290$ (885) from (223); cf. (84, 312, 1115, 1295, 1296, 1297, 1396, 1522)

NH₃(g)

$C_p = 8.04 + 0.0007T + 0.0000051T^2$; $\Delta F_{298.1}^0 = -3\,910$ (885)

Activity functions of ammonia vapor in mixtures with nitrogen at 318.1°K (1190) from (921)

<i>P</i>	<i>x</i> ₂ (NH ₃)	<i>f</i> ₂	<i>f</i> ₂ ⁰	<i>f</i> ₂ ⁰ <i>x</i> ₂	<i>k</i> ₂	<i>k</i> ₂ / <i>f</i> ₂ ⁰	<i>k</i> ₂ / <i>P</i>
7.123	1.000	6.759	6.759	6.759	6.759	1.000	0.952
10.133	0.7040	6.774	9.40	6.615	9.62	1.022	.949
11.716	.6393	6.783	10.73	6.86	10.61	0.990	.906
13.272	.5655	6.791	12.02	6.88	12.05	1.003	.905
23.695	.3313	6.845	19.75	6.54	20.67	1.046	.872

NH₃(g).—(Continued)

<i>P</i>	<i>x</i> ₂ (NH ₃)	<i>f</i> ₂	<i>f</i> ₂ ⁰	<i>f</i> ₂ ⁰ <i>x</i> ₂	<i>k</i> ₂	<i>k</i> ₂ / <i>f</i> ₂ ⁰	<i>k</i> ₂ / <i>P</i>
32.818	0.2478	6.894	25.45	6.26	27.80	1.078	0.846
47.912	.1743	6.974	(32.65)	(5.69)	40.00	(1.225)	.835
60.864	.1484	7.043	(37.09)	(5.50)	47.45	(1.279)	.780

Activity functions of ammonia vapor in mixtures with 1:3 nitrogen-hydrogen mixtures (1190) from (831)

<i>P</i>	<i>f</i> ₂ <i>x</i> ₂ <i>k</i> ₂ / <i>P</i>			<i>f</i> ₂ <i>x</i> ₂ <i>k</i> ₂ / <i>P</i>			<i>f</i> ₂ <i>x</i> ₂ <i>k</i> ₂ / <i>P</i>		
	(253.1°)			(273.1°)			(291.1°)		
v.p	1.833	1.0000	0.972	4.045	1.0000	0.954	7.351	1.0000	0.927
50	1.946	0.0570	.683	4.271	0.1000	.854	7.716	0.1885	.818
100	2.071	.0339	.611	4.533	.0581	.780	8.174	.1050	.778
300	2.655	.0150	.590	5.753	.0340	.564	10.309	.0597	.575
600	3.858	.0126	.510	8.219	.0246	.555	14.608	.0476	.512
1000	6.344	.0109	.582	13.239	.0209	.634	23.241	.0403	.577

The vapor pressure of ammonia was taken as 1.88 at 253.1°, 4.24 at 273.1° and 7.93 atm. at 291.1°, and the molal volumes as 25.84 at 253.1°, 26.69 at 273.1° and 27.74 cm³ at 291.1°K.

½N₂(g) + ¾H₂(g) = NH₃(g)

$\Delta F^0 = -9\,500 + 4.96T \ln T + 0.000575T^2 - 0.00000085T^3 - 9.61T$; $\Delta F_{298.1}^0 = -3\,910$ (885) from (537–544, 955); cf. (183, 185, 281, 486, 487, 488, 535, 536, 552, 553, 554, 556, 557, 558, 735, 736, 830, 832, 838, 1055)

$-R \ln K_p = -9\,274 + 4.96T \ln T + 0.000575T^2 - 0.00000085T^3 - 9.860T$ (1193)

<i>T</i>	<i>K</i> _p	<i>I</i>	<i>T</i>	<i>K</i> _p	<i>I</i>
<i>P</i> = 10 atm. (832)					
598.1	0.0401	-9.845	698.1	0.00919	-9.856
623.1	.0266	-9.848	723.1	.00659	-9.815
648.1	.0181	-9.839	748.1	.00516	-9.907
673.1	.0129	-9.872	773.1	.00381	-9.851

P = 30 atm. (832)

623.1	0.0273	-9.900	723.1	0.00676	-9.866
648.1	.0184	-9.872	748.1	.00515	-9.903
673.1	.0129	-9.872	773.1	.00386	-9.877
698.1	.00919	-9.857			

<i>T</i>	<i>K</i> _p	<i>T</i>	<i>K</i> _p	<i>T</i>	<i>K</i> _p
<i>P</i> = 50 atm. (832)					
623.1	0.0278	698.1	0.00932	748.1	0.00513
648.1	.0186	723.1	.00690	773.1	.00388
673.1	.0130				

P = 100 atm. (832)

648.1	0.0202	698.1	0.00987	748.1	0.00532
673.1	.0137	723.1	.00725	773.1	.00402

P = 300 atm. (832)

723.1	0.00884	748.1	0.00674	773.1	0.00498
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P = 600 atm. (832)

723.1	0.01294	748.1	0.00895	773.1	0.00651
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P = 1000 atm. (832)

723.1	0.02328	748.1	0.01493		
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NH₃(l)

$C_p = 47.3 - 0.2476T + 0.000516T^2$ (1193); cf. (402, 760); $\Delta F_{298.1}^0 = -2\,620$ (885), $-2\,570$; $\Delta H_{298.1}^0 = -16\,258$, revised value (1193)

NH₃(l) = NH₃(g)

$\Delta F^0 = 10\,450 + 39.26T \ln T - 0.1241T^2 + 0.0000850T^3 - 233.791T$ (range 189 to 398°K); $\Delta F_{298.1}^0 = -1\,290$ (885), $-1\,340$; $\Delta H_{298.1}^0 = 5\,264$; corrected for fugacity of liquid and vapor (1193) from (81, 181, 227, 255, 321, 760, 1405); $\Delta H_{298.9}^0 = 5\,730$ (445); cf. (311) and Vol. V, p. 138

$\text{NH}_3(\text{s})$
 $C_p = 0.20 + 0.0639T$ (70 – 170°K); $\Delta F_{298.1}^0 = -1\ 585$; $\Delta H_{298.1}^0 = -15\ 109$ (1193) from (402)

$\text{NH}_3(\text{s}) = \text{NH}_3(\text{g})$
 $\Delta F^0 = 7\ 336 - 7.84T \ln T + 0.0316T^2 - 0.00000085T^3 + 2.916T$ (range 146 to 196°K); $\Delta F_{298.1}^0 = -2\ 325$; $\Delta H_{298.1}^0 = 4\ 125$; vapor pressures corrected for fugacity of solid and vapor (1193) from (181, 227, 746, 1038)

$\text{NH}_3(\text{aq})$
 $\Delta F_{298.1}^0 = -6\ 300$ (885); for activity coefficient in aqueous salt solutions at 298.1°K, *v.* (7, 1175, 1181, 1226)

$\text{NH}_3(\text{g}) = \text{NH}_3(\text{aq})$
 $\Delta F_{298.1}^0 = -2\ 390$ (885); *cf.* (7, 464, 904, 1226)

$\text{NH}_3(\text{in } C_7H_8, \text{ toluene}) + H_2O(l) = NH_4OH(aq)$ (1181)

<i>T</i>	$x(\text{NH}_3)$	$m(\text{NH}_4\text{OH})$	K_m
298.1	0.0004006	0.7347	1 833
	.0004629	.8394	1 813

NH_4^+ ; $\Delta F_{298.1}^0 = -18\ 930$ (885)

$\text{NH}_4\text{OH}(aq)$; $\Delta F_{298.1}^0 = -62\ 860$ (885)

$\text{NH}_3(aq) + H_2O(l) = \text{NH}_4\text{OH}(aq)$; $\Delta F^0 = 0$ (885)

$\text{NH}_4\text{OH}(a) = \text{NH}_4^+ + \text{OH}^-$
 $K_{298.1} = 18.1 \times 10^{-6}$ (1083); $\Delta F_{298.1}^0 = 6\ 470$ (885); *cf.* (800)

<i>T</i>	$K \times 10^6$	<i>T</i>	$K \times 10^6$	<i>T</i>	$K \times 10^6$
291.1	17.2	348.3	16.4	429.1	6.28
298.1	18.1	373.1	13.5	491.1	1.80
324.1	18.1	397.9	10.4	579.1	0.093

$\text{NOCl}(g)$; $\Delta F_{298.1}^0 = 16\ 010$ (885)

$\text{NO}(g) + \frac{1}{2}\text{Cl}_2(g) = \text{NOCl}(g)$
 $\Delta F^0 = -9\ 100 + 14.3T$; $\Delta F_{298.1}^0 = -4\ 840$ (885) from (1453); *cf.* (1446, 1464)

<i>T</i>	$\log K_p$	<i>T</i>	$\log K_p$	<i>T</i>	$\log K_p$
503	0.822	605	0.152	695	-0.248
531	0.608	641	0.025	704	-0.316
589	0.206	678	-0.133	733	-0.497

$\text{HNO}_3(aq) + 3\text{HCl}(aq) = \text{NOCl}(g) + \text{Cl}_2 + 2\text{H}_2\text{O}(l)$ (184)

$\text{NH}_4\text{Cl}(s)$; $\Delta F_{298.1}^0 = -47\ 810$ (1189) from (193, 1231)

$\text{NH}_4\text{Cl}(g) = \text{NH}_3(g) + \text{HCl}(g)$ (1376, 1377); *cf.* (44, 534, 717, 1060, 1164, 1169, 1170, 1287)

<i>T</i>	553	563	573	583	593	603
K_p	0.0790	0.1996	0.2333	0.3082	0.4030	0.544

$\frac{1}{2}\text{H}_2(g) + \text{NH}_4\text{OH}(0.05m) + \text{HgCl}(s) = \text{Hg}(l) + \text{NH}_4\text{Cl}(s) + \text{H}_2\text{O}(\text{in satd. } \text{NH}_4\text{Cl})$

$E_{298.1} = 0.6924$ (193); $\Delta H = -70\ 600$; $\Delta F_{298.1}^0 = -14\ 670$ (1189)

$\text{NH}_4\text{Cl}(\alpha\text{-s})$; $\Delta F_{298.1}^0 = -47\ 810$ (1189) from (193)

$\text{NH}_4\text{Cl}(\beta\text{-s}) = \text{NH}_4\text{Cl}(\text{equilib. vapor})$
 $\log p = -1\ 920.357/T + 9.778609 \log T - 24.081$ (1371); *cf.* (649, 712, 1169, 1170, 1196, 1379, 1510)

$\text{NH}_4\text{Cl}(\alpha\text{-s}) = \text{NH}_4\text{Cl}(\beta\text{-s})$
 $\Delta H = 1\ 030$ (1303); $\Delta F_{457.6}^0 = 0$ (1302)

$\text{NH}_4\text{Cl} \cdot 3\text{NH}_3(s) = \text{NH}_4\text{Cl}(s) + 3\text{NH}_3(g)$ (1457) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
237.1	0.184	262.3	0.730
244.5	.217	267.1	.961
246.1	.237	273.1	1.362
250.1	.316	276.1	1.651
253.1	.408	278.1	1.862
255.4	.474	279.1	1.947
257.1	.520	280.1	2.184
260.1	.638	281.1	2.368

$\text{NH}_4\text{Cl} \cdot 6\text{NH}_3(s) = \text{NH}_4\text{Cl} \cdot 3\text{NH}_3(s) + 3\text{NH}_3(g)$ (1457) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
237.1	0.763	246.1	1.178
240.1	.875	248.1	1.289
242.0	.987	250.1	1.395
244.5	1.098	252.1	1.487

$\text{NO}(g) + \frac{1}{2}\text{Br}_2(g) = \text{NOBr}(g)$ (1449)

$\text{NH}_4\text{Br}(g) = \text{NH}_3(g) + \text{HBr}(g)$ (1376, 1377); *cf.* (1288)

<i>T</i>	K_p	<i>T</i>	K_p	<i>T</i>	K_p
573	0.00192	613	0.0260	643	0.0186
593	.0233	623	.0202	653	.0167
603	.0260	633	.0203	661	.0053

$\text{NH}_4\text{Br}(\alpha\text{-s}) = \text{NH}_4\text{Br}(\beta\text{-s})$
 $\Delta F_{410.4}^0 = 0$ (1304)

$\text{NH}_4\text{Br}(\beta\text{-s}) = \text{NH}_4\text{Br}(\text{equilib. gas})$
 $\log P = -2\ 056.541/T + 9.54014 \log T - 23.8655$ (1371); *cf.* (712)

$\text{NH}_4\text{Br} \cdot \text{NH}_3(s) = \text{NH}_4\text{Br}(s) + \text{NH}_3(g)$ (1458) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
246.1	0.118	273.1	0.461
249.1	.145	282.1	.770
254.1	.191	287.9	1.020
263.1	.276	293.1	1.349
266.5	.322	299.1	1.737
270.1	.382	304.1	2.184

$\text{NH}_4\text{Br} \cdot 3\text{NH}_3(s) = \text{NH}_4\text{Br} \cdot \text{NH}_3(s) + 2\text{NH}_3(g)$ (1247, 1458) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
252.1	0.213	279.6	1.072*
255.1	.243	280.1	1.105
258.1	.299	282.9	1.197
263.1	.412	287.7	1.506
268.1	.562	292.6	1.796
273.1	.759	298.1	2.105
276.1	.905	303.2	2.428
278.1	.921		

* Quadruple point. Liquid phase containing 1 mole NH_4Br to 2.63 moles NH_3 .

$\text{NH}_4\text{Br} \cdot 6\text{NH}_3(s) = \text{NH}_4\text{Br} \cdot 3\text{NH}_3(s) + 3\text{NH}_3(g)$ (1458) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
241.1	0.711	258.1	1.375
245.3	.862	261.1	1.579
247.6	.908	263.1	1.684
247.8	.921	265.1	1.868
251.3*	1.099	268.1	2.092
254.3	1.184	270.3	2.295

* Above 253°K, the compound fuses.

$\text{NH}_4\text{Br}_3(s) = ?$ (382) (E)

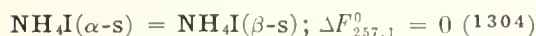
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
290.1	0.026	347.3	0.395
322.6	.138	357.3	.625
333.5	.209	365.4	.882

$\text{NH}_4\text{BrCl}_2(s) = ?$ (382) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
291.6	0.092	321.6	0.586
303.1	.191	327.1	.800
314.6	.408	328.9	.895

$\text{NH}_4\text{I}(g) = \text{NH}_3(g) + \text{HI}(g)$ (1376, 1377); *cf.* (1288)

<i>T</i>	$d_{\text{vap.}}, \text{ g/cm}^3$	<i>T</i>	$d_{\text{vap.}}, \text{ g/cm}^3$
573	0.000181	633	0.000874
593	.000307	643	.00105
613	.000488	653	.00129
623	.000647		



$$\text{NH}_4\text{I}(\beta\text{-s}) = \text{NH}_4\text{I} \text{ (equilib. gas)}$$

$$\log p = -7.714591/T - 10.04345 \log T + 39.8148 \text{ (1371); cf. (712)}$$

$\text{NH}_4\text{I} \cdot \text{NH}_3(\text{s}) = \text{NH}_4\text{I}(\text{s}) + \text{NH}_3(\text{g}) \text{ (1458) (E)}$			
T	P	T	P
246.1	0.013	252.1	0.132
257.1	.022	292.1	.236
259.1	.026	300.1	.368
263.1	.036	308.1	.597
267.3	.050	323.1	1.237
273.1	.075	329.1	1.500

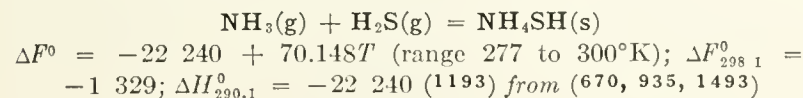
$\text{NH}_4\text{I} \cdot 3\text{NH}_3(\text{s}) = \text{NH}_4\text{I} \cdot \text{NH}_3(\text{s}) + 2\text{NH}_3(\text{g}) \text{ (1458) (E)}$			
T	P	T	P
246.1	0.171	273.1	0.500
250.1	.178	282.1	.763
254.1	.197	287.7	.921
259.1	.237	292.6	1.105
263.3*	.309	298.1	1.309
268.1	.382	303.1	1.526

* The compound becomes liquid above 261°K.

$\text{NH}_4\text{I} \cdot 6\text{NH}_3(\text{s}) = \text{NH}_4\text{I} \cdot 3\text{NH}_3(\text{s}) + 3\text{NH}_3(\text{g}) \text{ (1458) (E)}$			
T	P	T	P
244.1*	0.572	268.1	1.362
248.1	.671	273.1	1.645
251.9	.757	277.8	1.862
256.1	.862	282.5	2.132
260.3	1.073	284.5	2.283
267.1	1.316		

* The compound becomes liquid above 245.1°K.

$\text{NH}_4\text{IBr}_2(\text{s}) = (?) \text{ (382) (E)}$			
T	P	T	P
380.1	0.086	417.6	0.412
397.6	.182	427.1	.612
407.1	.268	434.1	.842

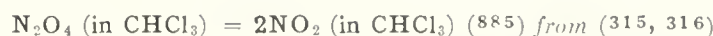
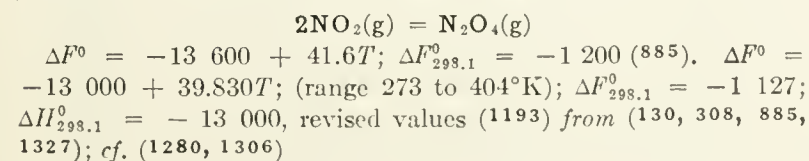
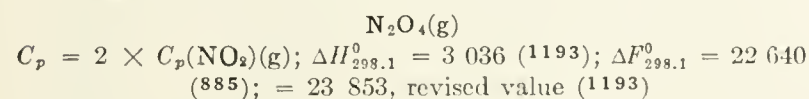


$\text{N}_2\text{O}(\text{aq})$
Activity coefficient in aqueous salt solutions (1175) from (468, 767, 945)

$\text{N}_2\text{O}(\text{g}) = \text{N}_2\text{O}(\text{aq}); \Delta F_{298.1}^0 = 2.268 \text{ from (468)}$			
$\text{N}_2\text{O} \cdot x\text{H}_2\text{O}(?) = \text{N}_2\text{O}(\text{g}) + \text{H}_2\text{O}(\text{l}) \text{ (1469, 1470, 1472, 1473) (E)}$			
T	P	T	P
264.1*	3.6	280.2	21.5
268.4*	5.8	283.8†	34.7
273.1	9.7	$\Delta H = 15.000$	

* Ice present.

† Critical decomposition point above 285.1°K.



x_{CHCl_3}	$x_{\text{N}_2\text{O}_4}$	x_{NO_2}	$K \times 10^8$
0.0	1.00	0.00094	88
.27	0.73	.00080	87
.46	.54	.00067	83
.70	.30	.00045	67
.875	.125	.00029	66
.934	.066	.00019	52
.950	.050	.00015	43
.963	.037	.00012	35
.982	.018	.00010	49

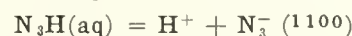


Vapor density = 20.66 at 553.1°K, $P = 0.153$ atm. (1197)

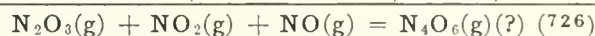


T	P	T	P
243.1	0.118	283.2	0.691
247.1	0.151	287.1	0.789
255.1*	0.224	291.5	0.941
263.1	0.329	293.9	1.007
273.1	0.480	298.1	1.234

* The compound becomes liquid above 251°K.

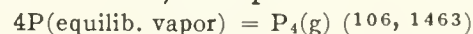


T	273.1	278.1	283.1	288.1	293.1
$K \times 10^5$	0.8	0.9	1.0	1.1	1.2



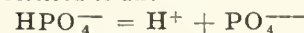
$P = 0.300$ at 240.1°K (213)

P, Phosphorus

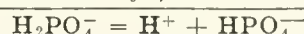
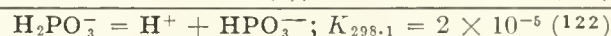


T	Vapor density*	T	Vapor density*
773	4.35	1757	3.632
1313	4.50	1950	3.226

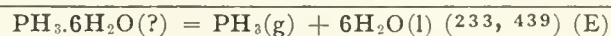
* $\text{P}_4(\text{g})$; v.d. = 4.294 referred to air.



$$K_{291.1} = 3.6 \times 10^{-13} \text{ (1); } K_{291.1} = 2 \times 10^{-12} \text{ (122)}$$



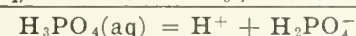
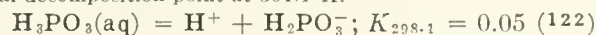
$$K_{291.1} = 2.0 \times 10^{-7} \text{ (1); } = 8 \times 10^{-7} \text{ (122); } = 5.5 \times 10^{-8} \text{ (121); cf. (997, 1162)}$$



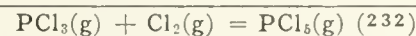
T	P	T	P
266.70*	1.0	284.1	6.7
273.1*	1.63	287.1	8.9
275.3	2.3	288.1	9.8
277.1	3.0	290.1	11.0
279.9	3.9	293.1†	15.1
282.1	5.1		

* From (439); all other values from (233).

† Critical decomposition point at 301.1°K.



$$K_{291.1} = 0.011 \text{ (1); } K_{298.1} = 0.009 \text{ (1268); } = 0.0083 \text{ (1344); cf. (782, 1162)}$$



T	Vapor density ($P = 1$)	T	Vapor density ($P = 1$)	T	Vapor density ($P = 1$)
455.1	5.08	503.1	4.80	561.1	3.67
463.1	4.99	523.1	4.00	573.1	3.65
473.1	4.85	547.1	3.84		

PCl₃(g) + Cl₂(g).—(Continued) c = mole per liter at saturation; PCl₅(s) in equilib. (1377)

T	c	% dissoci.	P
363.1	0.000945	100+	0.024
373.1	.00159	100+	.046
383.1	.00273	2.8	.088
393.1	.00446	7.1	.154
403.1			.251
413.1	.01098	4.0	.387
423.1	.01655	2.0	.586
433.1	.02368	4.8	.882

PCl₅(s) = PCl₅ (equilib. vapor) (1371); cf. (262, 640, 1059, 1161, 1376, 1377)

T	P	T	P
363.1	0.0237	433.1	0.882
393.1	.154	435.9	1.000
413.1	.387	470.1	1.209
423.1	.586		(liquid)

PH₄I(s) = PH₄I (equilib. vapor) (1371); cf. (714)

T	P	T	P
288.1	0.0474	333.1	0.8684
303.1	.1419	335.7	1.00
313.1	.2618	339.1	1.207
323.1	.4844		

HP₂O₇²⁻ = H⁺ + P₂O₇²⁻; $K_{298.1} = 3.6 \times 10^{-9}$ (1)H₂P₂O₇⁻ = H⁺ + HP₂O₇⁻; $K_{298.1} = 2.9 \times 10^{-7}$ (1)H₃P₂O₇ = H⁺ + H₂P₂O₇⁻; $K_{298.1} = 0.011$ (1)H₄P₂O₇(aq) = H⁺ + H₃P₂O₇⁻; $K_{298.1} = 0.14$ (1)

As, Arsenic

As (gray); ΔF^0 , $\Delta H^0 = 0$ As₂(g) = 2As(g) (1158)

T	1 073	1 173	1 273	1 373	1 473
K	0.000211	0.00105	0.00414	0.01342	0.0368

As₄(g) = 2As₂(g) (1158)

T	1 073	1 173	1 273	1 373	1 473
K	0.00397	0.0118	0.0296	0.0658	0.1316

HAsO₂ (in C₅H₁₂O, amyl alcohol) = HAsO₂(aq); see Vol. III, p. 421AsO₂⁻ + HAsO₂(aq) = HAs₂O₄⁻; $K_{298.1} = 0.2$ to 0.7 (32)As(s) + $\frac{3}{2}$ H₂(g) = AsH₃(g) (518)AsH₃·6H₂O(?) = AsH₃(g) + 6H₂O(l) (439) (E) $\Delta H = 17\ 750$ to $18\ 830$

T	P_{AsH_3}	T	P_{AsH_3}
273.1	0.807	286.1	3.83
274.7	1.000	291.35	6.79
277.25	1.289	294.1	8.85
283.1	2.65	301.3*	17.5

* Critical decomposition point.

H₃AsO₃(aq) = AsO⁺ + OH⁻ + H₂O(l) $K_{298.1} = 0.5 \times 10^{-14}$; corrected for error in calc. (1507)H₃AsO₃(aq) = H⁺ + H₂AsO₃⁻ $K_{298.1} = 2.1 \times 10^{-8}$ (1561)H₃AsO₄(aq) = H⁺ + H₂AsO₄⁻ $K_{298.1} = 0.00432 + 0.004c^{1/2}$ (1507); cf. (1486)

$c_{\text{(HCl)}}$	0.05057	0.1011	0.1268
$K_{298.1}$	0.00530	0.00560	0.00575

H₃AsO₃(aq) + H₂O(l) = H₃AsO₄(aq) + 2H⁺ + 2E⁻ $\Delta F_{298.1}^0 = 26\ 923$; $E_{298.1}^0 = -0.5834$ (1507)H₃AsO₃(aq) + I₃⁻ = H₃AsO₄(aq) + 2H⁺ + 3I⁻Corrected for errors in calc. (1507); cf. (1236, 1237); for $\mu_c^{1/2} = ca.$ 0.3 – 0.4, $\Delta F_{298.1}^0 = 1\ 700$

d_{25}^{25}	$c_{\text{(ΣI)}}$	$c_{\text{(ΣAs)}}$	$10^3 \times c_{\text{(I}_2\text{)}}$	$\mu_c^{1/2}$	K_c
1.0232	0.18568	0.10128	0.0625	0.392	0.0546
1.0250	.20686	.10121	.0943	.400	.0597
1.0140	.09059	.05198	.00727	.290	.0555
1.0155	.10734	.04937	.0720	.300	.0580
1.0148	.10248	.04935	.0446	.300	.0595
1.0144	.10140	.04934	.0394	.298	.0601
			.0175	.333	.0543
Mean $K_c = 0.057 \pm 4\%$					

As₂O₅·xH₂O(s) = ? + yH₂O(g) (844) (E)

x	T	P	x	T	P
0.04	303.1	0.0016	1.89	303.1	0.0054
0.04	430.1	.026	2.2	373.1	1.044 to
1.48–0.19	430.1	.329			1.052
1.70	373.1	.042	4	303.1	0.0054

2As₂S₂(g) + 4H₂(g) = 4H₂S(g) + As₄ $P_{\text{H}_2\text{S}}/P_{\text{H}_2} = 3.70$ at 883°K (1124)As₂Se₅(g) = ? (1417)As₄S₄(g) = ? (1417)

Sb, Antimony

Sb(s) = Sb⁺⁺⁺ + 3E⁻; $E_{298.1}^0 = -0.244$ (701)Sb₄(g) = 2Sb₂(g) (105)

T	w	Average composition
1 845	310	Sb _{2.96}
1 913	282	Sb _{2.68}

Sb(s) + 4OH⁻ + 3E⁻ = SbO₂⁻ + 2H₂O(l) $E_{298.1} = 0.675 - 0.058/3 \log m_{\text{SbO}_2^-}$ in 10*m* KOH (524)SbO₂⁻ + 2OH⁻ + 2E⁻ = SbO₃⁻ + H₂O(l) $E_{298.1} = 0.589 - 0.058/2 \log m_{\text{SbO}_3^-}/m_{\text{SbO}_2^-}$ in 10*m* KOH (524)Sb₂O₄(s) = Sb₂O₃(s) + $\frac{1}{2}$ O₂(g)At 1223°K, $P = 1.00$ (431)Sb₂S₃(s) + 3H₂(g) = Sb₂(s) + 3H₂S(g) (1125)

T	713	783	828	883	898
% gas as H ₂ S.....	43.22	48.6	51.8	56.01	56.92

Bi, Bismuth

Bi(s) + 4OH⁻ = BiO₂⁻ + 2H₂O(l) + 3E⁻ (524) $\frac{3}{2}$ H₂(g) + BiOCl(s) = Bi(s) + H⁺ + Cl⁻ + H₂O(l) (1085)Pt, H₂(1 atm.), HCl (*xm*), HCl (*xm* + BiOCl(s)), Bi(s) (1085)

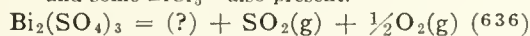
$m_{\text{(HCl)}}$	$E_{298.1}$	$m_{\text{(HCl)}}$	$E_{298.1}$	$E_{288.1}$	$E_{308.1}$
0.000983	0.28249	0.1041	0.20221	0.20447	0.20011
.001010	.28212	.2304	.08887	.19160	.18617
.003175	.26071	.5005	.17563		
.009022	.24293				
.02007	.22947		$E_{298.1}^0$	$E_{288.1}^0$	$E_{308.1}^0$
.04586	.21606		0.1599	0.1635	0.1563

BiOCl(s) + 2H⁺ + 3Cl⁻ = H₂O(l) + BiCl₄⁻* (1082.1); cf. (678.5)

d_4^{25}	$c_{\text{(ΣH+)}}$	$c_{\text{(ΣCl)}}$	$c_{\text{(ΣBi)}}$
1.002	0.3438	0.3477	0.00130
1.007	.4237	.4350	.00376
1.009	.4295	.4414	.00396
1.009	.4698	.4892	.00646
1.010	.4960	.5221	.00869
1.011	.5006	.5276	.00899
1.012	.5399	.5796	.01323
1.013	.5714	.6244	.01767
1.015	.5742	.6299	.01856

BiOCl(s) + 2H⁺ + 3Cl⁻.—(Continued)

d_4^{25}	$c(\Sigma H^+)$	$c(\Sigma Cl^-)$	$c(\Sigma Bi)$
1.015	0.6222	0.7038	0.02720
1.018	.6434	.7375	.03138
1.020	.6537	.7579	.03473
1.025	.7223	.8824	.05338
1.028	.7343	.9125	.05936
1.036	.8079	1.0760	.08937
1.044	.8746	1.2277	.1177
1.048	.8752	1.2724	.1324
1.055	.9488	1.4348	.1620
1.061	.9891	1.5321	.1810
1.066	1.016	1.6235	.2025
1.066	1.020	1.6350	.2050
1.075	1.065	1.7706	.2352
1.083	1.105	1.9021	.2657
1.122	1.293	2.5578	.4216
1.157	1.481	3.1865	.5685
1.185	1.599	3.6366	.6792
1.221	1.758	4.2552	.8324
1.237	1.799	4.5056	.9022
1.288	2.025	5.325	1.100
1.329	2.115	6.066	1.317

* Some Bi⁺⁺⁺ and some BiCl₅⁻ also present.

C, Carbon

C (graphite)

$$\Delta F^0, \Delta H^0 = 0 \text{ (880, 885); } C_p = 1.1 + 0.0048T - 0.0000012T^2 \text{ (885)}$$

C (diamond)

$$\Delta F_{298.1}^0 = 390; \Delta H_{298.1}^0 = 180 \text{ (885)}$$

C (graphite) = C (diamond)

$$\Delta F^0 = -27 + 0.7T \text{ (885) from (1264); cf. (1263)}$$

CO(g)

$$C_p = 6.5 + 0.001T; \Delta F^0 = -26\,600 - 2.15T \ln T + 0.00215T^2 - 0.0000002T^3 - 8.20T; \Delta F_{298.1}^0 = -32\,510 \text{ (885)}$$

CO₂(g)

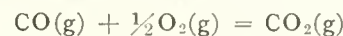
$$C_p = 7.0 + 0.0071T - 0.00000186T^2; \Delta F^0 = -94\,110 + 0.60T \ln T - 0.00065T^2 + 0.00000011T^3 - 3.74T; \Delta F_{298.1}^0 = -94\,260 \text{ (885)}$$

Activity function of carbon dioxide in nitrogen and in hydrogen (1190)

T	Gas	P	x_2	a_2 (l)	a_2/N_2	f_2/N_2	k_2/P
221.5	N ₂	40.6	0.222	1.086	4.89	29.55	0.728
		60.5	.182	1.133	6.22	37.60	.621
		74.6	.176	1.167	6.63	40.07	.537
		78.4	.176	1.176	6.68	40.35	.515
		92.9	.179	1.212	6.77	40.90	.440
		108.4	.188	1.252	6.66	40.25	.371
		122.0	.200	1.289	6.44	38.93	.319
		125.8	.205	1.299	6.33	38.28	.304
		139.9	.230	1.338	5.82	35.13	.251
		143.2	.237	1.347	5.68	34.34	.240
	H ₂	146.6	.248	1.357	5.47	33.05	.225
		148.6	.256	1.364	5.33	32.19	.216
		153.4	.270	1.376	5.10	30.80	.201
		78.4	.120	1.176	9.80	59.15	.755
		95.3	.105	1.218	11.60	70.08	.736
		100.6	.101	1.232	12.20	73.7	.733
		112.8	.094	1.264	13.45	81.2	.720
		157.3	.084	1.387	16.50	99.8	.634
	N ₂	53.7	.744	1.12	1.50	36.0	.67
		63.9	.668	1.12	1.68	40.3	.63
		65.1	.665	1.15	1.73	41.5	.64

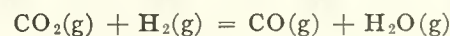
CO₂(g).—(Continued)

T	Gas	P	x_2	a_2 (l)	a_2/N_2	f_2/N_2	k_2/P
273.1	N ₂	68.2	0.642	1.16	1.81	43.4	0.64
		75.8	.616	1.17	1.90	45.6	.60
		76.5	.615	1.18	1.92	46.1	.60
		81.9	.603	1.19	1.98	47.4	.58
		88.6	.594	1.21	2.04	48.9	.55
	H ₂	78.4	.594	1.18	1.99	47.8	.61
		92.4	.534	1.22	2.20	54.9	.60
		103.0	.503	1.24	2.47	59.3	.58
		122.0	.458	1.30	2.84	68.1	.56



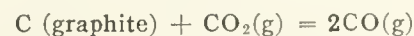
$$\Delta F^0 = -67\,510 + 2.75T \ln T - 0.0028T^2 + 0.00000031T^3 + 4.46T; \Delta F_{298.1}^0 = -61\,750 \text{ (885); cf. (118, 373, 1146)}$$

T	% dissoc.	K	I	Lit.
1 395	0.0142	837 000	4.7	(821)
1 400	.015	781 000	4.6	(1058)
1 443	.025	358 000	4.8	(821)
1 478	.032	247 000	4.4	(1058)
1 481	.028	295 000	3.9	(821)
1 498	.047	138 000	4.9	(821)
1 565	.064	87 300	4.9	(821)
1 823	.4	5 600	3.3	(915)



$$\Delta F^0 = 10\,100 - 1.81T \ln T + 0.00445T^2 - 0.00000068T^3 - 0.54T; \Delta F_{298.1}^0 = 7\,240 \text{ (885); cf. (16, 17, 19, 216, 368, 377, 401, 535, 555, 585, 588, 590, 631)}$$

T (566, 567)	K	I
959	0.534	-0.59
1 059	0.840	-0.53
1 159	1.197	-0.56
1 259	1.571	-0.52
1 278	1.620	-0.49
1 359	1.960	-0.50
1 478	2.126	-0.23
1 678	2.490	-0.06
T (559)	K	I
1 503	3.05	-0.65
1 528	2.68	-0.51
1 538	2.85	-0.58
1 582	2.72	-0.37
1 597	2.93	-0.47
1 643	3.26	-0.64
1 768	3.83	-0.61
1 783	3.66	-0.47
1 797	3.86	-0.55
1 824	3.56	-0.32
T (364)	K	
967	1.56	
1 002	1.58	
1 009	1.73	
1 017	1.66	



$$\Delta F^0 = 40\,910 - 4.9T \ln T + 0.00495T^2 - 0.00000051T^3 - 12.66T; \Delta F_{298.1}^0 = 29\,240 \text{ (885) from (1210); cf. (25, 160, 283, 284, 405, 406, 407, 408, 700, 969, 1211, 1212, 1307, 1326, 1432)}$$

T	K	I
1 123	14.11	-12.16
1 173	43.07	-12.73
1 223	73.77	-12.43
1 273	167.5	-12.72
1 323	268.3	-12.46

C (graphite) + CO₂(g).—(Continued)

<i>T</i>	<i>K</i>	<i>I</i>
1 373	664.7	-13.15
1 473	1 665	-12.95
Average = -12.66		

2CO₂(g) + ½S₂(g) = 2CO(g) + SO₂(g)
 $\Delta F^0 = 51\,760 - 2.75T \ln T + 0.0028T^2 - 0.00000031T^3 - 7.866T$, corrected for COS(g) (885) from (414)

No. Exps.	<i>T</i> (mean)	log <i>K</i>	<i>I</i>
4	1 275	-3.56	-7.789
4	1 460	-2.38	-7.943

CO₂(aq)

$\Delta F^0_{298.1} = -92\,250$ (885); for activity coefficient in aqueous salt solutions, *v.* (1175) from (422, 468)

CO₂(g) = CO₂(aq)

$K_{298.1} = 0.0338$ (885) from (145, 744); $\Delta F^0_{298.1} = 2\,010$ (885).
 $K_{298.1} = 0.037$; $\Delta F^0_{298.1} = 1\,954$; $\Delta H = -4\,900$, revised values (1175); cf. Vol. III, p. 260

CO₂·6H₂O(?) = CO₂(g) + 6H₂O(l) (1472, 1473, 1554) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	12.3	278.4	21.8
273.58	12.7	279.2	23.3
275.8	16.7	279.9	26.1
276.7	17.9	283.1	44.3

$\Delta H = 14\,710$

CO₃²⁻; $\Delta F^0_{298.1} = -125\,760$ (885)

HCO₃⁻; $\Delta F^0_{298.1} = -140\,000$ (885)

HCO₃⁻ = H⁺ + CO₃²⁻

$K_{298.1} = 3.7 \times 10^{-11}$; $\Delta F^0_{298.1} = 14\,240$ (885) from (35, 139, 974); cf. (447, 1191, 1341, 1346, 1353, 1354, 1490)

CO₃²⁻ + H₂O(l) = HCO₃⁻ + OH⁻ (447)

CO₂(g) + CO₃²⁻ + H₂O(l) = 2HCO₃⁻

$\Delta F^0_{298.1} = -3\,546$ (1191); cf. (974, 1341, 1353, 1354, 1490)

HCOOH(l)

$\Delta F^0_{298.1} = -84\,040$ (885); $\Delta S^0_{298.1} = -44.5$; $\Delta F^0_{298.1} = -86\,400$ (484, 485)

HCOOH(aq); $\Delta F^0_{298.1} = -87\,920$ (885)

HCOOH(aq) = H₂O(l) + CO(g)

$\Delta F^0 = 5\,200 - 21.3T$ (885); $\Delta F^0_{298.1} = -1\,150$ (885) from (164);
 $K_{429.4} = 90.8, 89.3, 89.6$; $K_{491.2} = 313$; = 306

HCOOH(l) = HCOOH(aq)

$\Delta F^0_{298.1} = -3\,880$ (885) from (164)

H₂CO₃(aq); $\Delta F^0_{298.1} = -148\,810$ (885)

CO₂(g) + H₂O(l) = H₂CO₃(aq); $\Delta F^0 = 0$ (885); cf. (719)

H₂CO₃(aq) = H⁺ + HCO₃⁻

$\Delta F^0_{298.1} = 8\,810$ (885) from (754); cf. (719, 764, 982, 1165, 1435, 1491)

H₂CO₃(aq) + CO₃²⁻ = 2HCO₃⁻

$K_{298.1} = 9\,400$ (885); cf. (974, 1341, 1490)

CH₄(g)

$C_p = 3.00 + 0.0228T - 0.00000480T^2$ (1180) from (343, 344, 1005); cf. (402, 481); $\Delta F^0 = -16\,300 + 6.6T \ln T + 0.0008T^2 - 0.0000002T^3 - 26.0T$; $\Delta F^0_{298.1} = -12\,800$ (885). $\Delta F^0 = -14\,342 + 11.1T \ln T - 0.0081T^2 + 0.0000006T^3 - 51.74T$; $\Delta H^0_{298.1} = -16\,963$; $\Delta F^0_{298.1} = -11\,617$ (revised values) (1180)

C (graphite) + 2H₂(g) = CH₄(g)

$\Delta F^0 = -14\,342 + 11.1T \ln T - 0.0081T^2 + 0.0000006T^3 - 51.74T$ (range 748 to 900°K); between 1470 and 1720°K the average value of *I* is -48.21; $\Delta H^0_{298.1} = -16\,963$; $\Delta F^0_{298.1} = -11\,617$, revised value (1180) from (966, 1163); cf. (150, 151, 152, 283, 310, 428, 965, 966, 967, 1163); cf. CH₄(g)

CO(g) + 3H₂(g) = CH₄(g) + H₂O(g) (678, 1065); cf. (818.5, 590, 965)

<i>T</i>	1 133.1	1 173.1	1 213.1	1 253.1	1 307.1	1 325.1
log <i>K</i>	-2.37	-2.75	-3.09	-3.45	-4.06	-4.31

CO₂(g) + 4H₂(g) = CH₄(g) + 2H₂O(g)

$\Delta F^0 = -35\,093 + 12.38T \ln T - 0.00415T^2 - 0.00000025T^3 - 39.91T$ (range 570 to 670°K); $\Delta H^0_{298.1} = -38\,401$; $\Delta F^0_{298.1} = -26\,339$ (1180); cf. (620, 678, 968, 1065, 1120)

<i>T</i>	681.1	709.1	765.1	773.1
<i>K</i>	3.13	2.64	1.69	1.58
Lit*.....	(968)	(678)	(968)	(678)

* See also (252, 408, 965, 1298).

CH₄·xH₂O(?) = CH₄(g) + xH₂O(l) (1469, 1470) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	26.5	287.4	123.5
274.2	30.0	289.2	152.0
278.6	47.0	290.4	178.5
281.6	63.5	292.4	232.0
283.0	75.0	293.4*	265.0
283.9	83.0		

* Critical decomposition point at *T* = 294.6°K.

CH₃Cl·6H₂O(?) = CH₃Cl(g) + 6H₂O(l) (332, 1472, 1473) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.409	287.45	2.401
273.6	.439	287.6	2.425
274.0	.420	288.0	2.510
275.5	.547	288.6	2.800
277.9	.733	289.3	2.990
279.6	.904	290.6	3.526
281.1	1.059	292.6	4.134
283.6	1.311	293.2	4.618
285.6	1.852	283.5*	4.861

* Critical decomposition point above 294.0°K.

COCl₂(g); $\Delta F^0_{298.1} = -48\,770$ (885)

CO(g) + Cl₂(g) = COCl₂(g)

$\Delta F^0 = -24\,100 + 4T \ln T + 3.5T$; $\Delta F^0_{298.1} = -16\,260$ (885) from (132, 645); cf. (31, 135, 280, 1511)

CCl₄(l)

$\Delta H^0_{298.1} = -75\,700$; $\Delta S^0_{298.1} = -50.84$; $\Delta F^0_{298.1} = -60\,550$ (833)

CO(g) + Br₂(g) = COBr₂(g)

$K = 0.185$ at 346.4°K; = 0.0475 at 454.4°K (1447)

COS(g); $\Delta F^0_{298.1} = -39\,600$ (885)

CO(g) + ½S₂(g) = COS(g) (885) from (874)

$\Delta F^0 = -22\,500 + 21.0T$; $\Delta F^0_{298.1} = -16\,230$ (885) from (874); cf. (1336, 1406, 1407)

<i>T</i>	$\Delta F^0/T$	<i>I</i>
533	-21.39	20.82
575	-18.10	21.03

CO(g) + S_{λ,μ}(l) = COS(g)

$K = 435$ at 533°K; 201 at 575°K (874)

C (graphite) + S₂(g) = CS₂(g) (23, 789, 885, 1406, 1407)

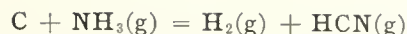
CN⁻; $\Delta F^0_{298.1} = 39\,370$ (885)

CNO⁻; $\Delta F^0_{298.1} = -23\,750$ (885)

HCN(g); $\Delta F^0_{298.1} = 28\,910$ (885); cf. (38)

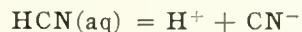
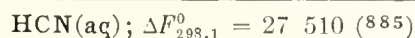
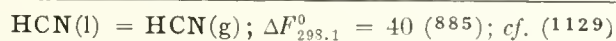
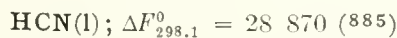
C (graphite) + ½N₂(g) + ½H₂(g) = HCN(g)

log $K_{2000} = -1.24$ or $\Delta F^0_{2000} = 11\,300$; $\Delta F^0 = 32\,000 - 10.3T$ (1497); $\Delta F^0_{298.1} = 28\,910$ (885); cf. (461, 462)

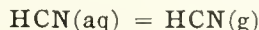


"Very active" charcoal supplied by Fixed Nitrogen Laboratory, Washington, D. C. (38); cf. (80, 817, 1475, 1476, 1513)

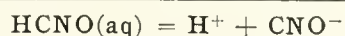
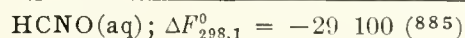
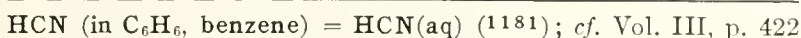
T	785	793	801	803	807	811
$10^6 K$	3.5	4.9	7.7	3.7	8.6	7.7



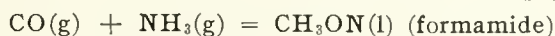
$K_{291.1} = 1.32 \times 10^{-9}$ (1491); $\Delta H = 11\,000$ (1402); $K_{298.1} = 2.06 \times 10^{-9}$; $\Delta F_{298.1}^0 = 11\,860$ (885); cf. (575, 803.1, 885, 1346)



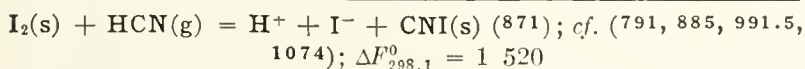
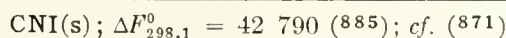
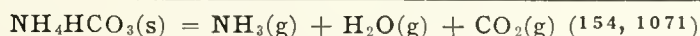
$K_{298.1} = 0.096$ (871); $\Delta F_{298.1}^0 = 1\,390$ (885); cf. (176) and Vol. III, p. 365



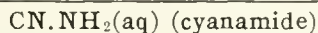
$K_{291.1} = 0.00012$ (1047, 1048); $\Delta F_{298.1}^0 = 5\,350$ (885)



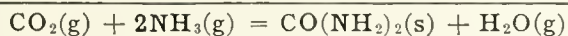
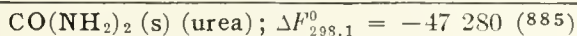
$K_{473.1} = 0.0000138$ (994)



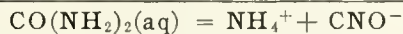
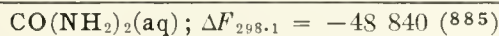
p_{HCN}	$m_{(\text{H}^+)}$	$m_{(\text{I}^-)}$	K
0.00115	0.0161	0.0065	0.091
.00605	.0361	.0144	.086
.00675	.0285	.0118	.049
.00360	.0268	.0100	.075
.00471	.0246	.0106	.055



$K_{298.1} = 5.4 \times 10^{-11}$ (745); cf. (522)

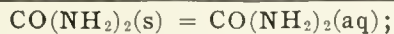


$K_{298.1} = 0.615$; $\Delta F_{298.1}^0 = 290$ (885) from (865); cf. (418, 962)

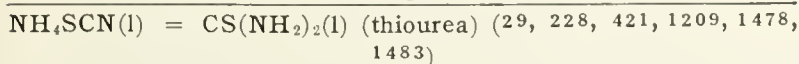
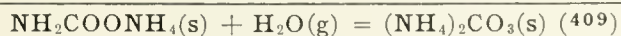
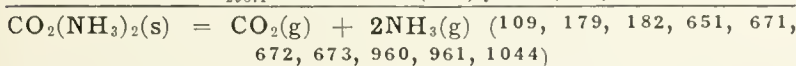


$\Delta F_{298.1}^0 = 6\,160$ (885) from (411, 1492, 1494); $\Delta H = 7\,500$; $\Delta F_{373.1}^0 = 5\,820$ (229, 1488); for values in $\text{C}_2\text{H}_6\text{O}(\text{l})$ and $\text{C}_2\text{H}_6\text{O}(\text{aq})$, v. (1260)

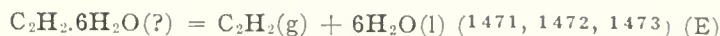
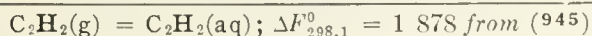
T	K	Lit.
334.15	0.000107	(229)
348.31	0.000146	(229)
373.1	0.000391	(411, 1492, 1494)



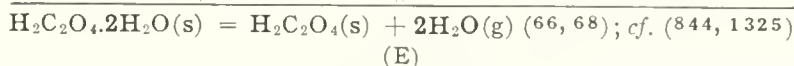
$\Delta F_{298.1}^0 = -1\,560$ (885) from (865)



For activity coefficient in aqueous salt solutions at 298.1°K, v. (945, 1174)



T	P	T	P
273.1	5.75	282.7	16.4
277.7	9.4	288.1	33.0
280.1	12.0	$\Delta H = 15\,000$	

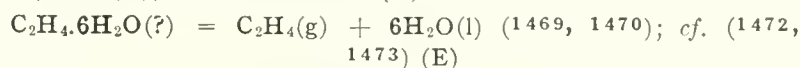


$\Delta H = 6\,330$ (Thomson, $\text{H}_2\text{O}(\text{l})$)

T	P	T	P
248.1	0.00007*	313.1	0.01025
258.1	.00014*	323.1†	.02053
273.1†	.00045	333.1	.03992*
288.1	.00151	343.1	.07623*
298.1†	.00354		

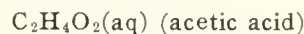
* Calc. from $\log P = 15.172 - 9661/(T + 250)$.

† From (66); all other values from (68).

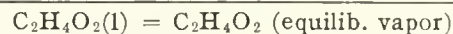


T	P	T	P
273.1	6.5	286.5	28.5
276.1	8.5	287.9	34.5
278.6	11.0	289.7	45.0
281.1	14.0	290.3*	59.0
284.1	21.0	$\Delta H = 15\,400$	

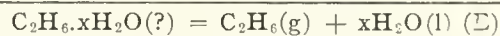
* Critical decomposition point at $T = 291.8^\circ\text{K}$.



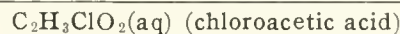
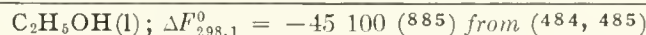
For activity coefficient in aqueous salt solutions, v. (1177) from (973, 1414)



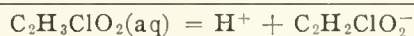
$\log K = 15\,000/4.57T - 1.75 \log T - 6.76$ (640, 1059)



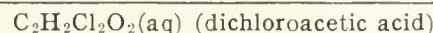
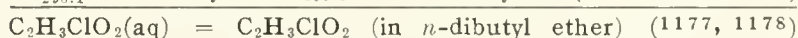
$P = 6.0$ at 273.1°K ; $= 28.0$ at 285.1°K ; critical decomposition point at about 285.1°K (1469, 1470)



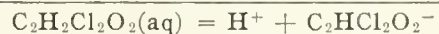
For activity coefficient in aqueous salt solutions at 298.1°K, v. (1177)



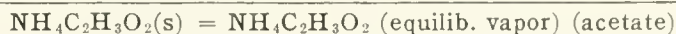
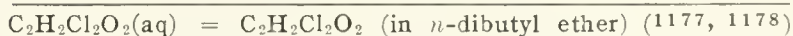
$\Delta F_{298.1}^0 = 3\,900$ from $K_{298.1} = 0.00139$ from (1102, 1177, 1344)



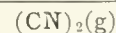
For activity coefficient in aqueous salt solutions at 298.1°K, v. (1177)



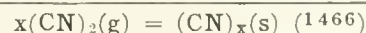
$\Delta F_{298.1}^0 = 1\,716$ from $K_{298.1} = 0.0553$ (1177); $K_{291.1} = 0.0583$ (1177, 1402)



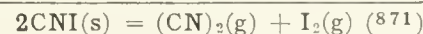
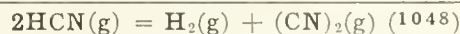
Vapor density = 0.20 g/cm^3 at 553°K , $p = 0.153 \text{ atm}$. (1197)



$\Delta F_{298.1}^0 = 92\,000$ (885); cf. (517, 1047, 1048, 1497)



$(\text{CN})_x$ is not a definite substance (1181)



$\Delta H = 41\,800$ (87.5); $= 48\,000$ (871); $\Delta F^0 = 32\,000 - 70T$; $\Delta F_{298.1}^0 = 11\,000$ (885)

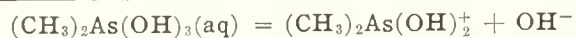
T	P	K
363.1	0.0045	2.00×10^{-5}
383.1	.0277	7.76×10^{-4}
389.6	.0436	1.91×10^{-3}
396.1	.0746	5.63×10^{-3}



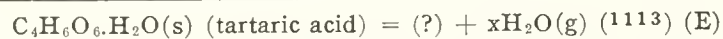
At $T = 298.1^\circ\text{K}$, $P = 0.0008$ to 0.0024 (916)



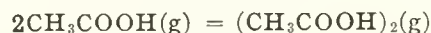
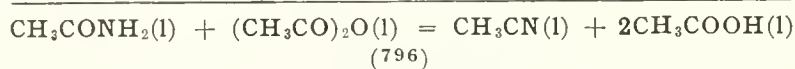
$$K_{298.1} = 6.4 \times 10^{-7} \text{ (716)}$$



$K_{298.1} = 3.8 \times 10^{-13}$ (conductivity) (716); $= 4.05 \times 10^{-13}$ (hydrolysis of chlorohydrate) (716); $= 2.63, 1.14$ and 1.35×10^{-13} (1561); $K_{273.1} = 4.15 \times 10^{-14}$ (hydrolysis of chlorohydrate) (1561)



T	P	T	P
293.37	0.00738	313.10	0.05664
298.10	.01359	323.10	.10653
302.99	.02393		



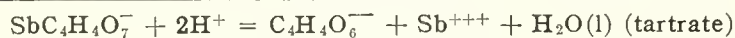
$$\log K = 16\,480/4.571T - 8.17 \text{ (640, 1059)}$$



$$\log p = 23\,649.7/T + 132.316 \log T - 404.1929 \text{ (1371)}$$



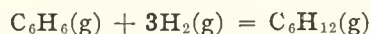
$$\log p = 1493.085/T + 24.96449 \log T - 71.5399 \text{ (1371)}$$



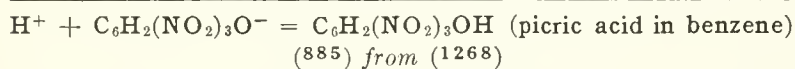
$$K_{298.1} = 10^{-11} \text{ (701)}$$



$$\Delta S_{298.1}^0 = -51.6 \text{ (867)}; \Delta F_{298.1}^0 = 27\,100 \text{ (885)}$$

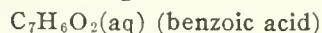


$$K_{539.6} = 5.47; K_{533.1} = 1.62; \Delta H_{546} = -53\,260; \text{ (230)}; \text{ cf. (358)}$$



c_W^*	c_B^*	$c_B^{1/2}/c_W$	γ (Picric)
0.0	0.0	15.4	1.00
.00208	.000932	14.9	0.97
.00327	.00225	14.5	.94
.00701	.0101	14.3	.93
.0101	.0199	14.0	.91
.0199	.0700	13.3	.86
.0334	.1772	12.6	.82

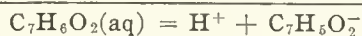
* c_W = concn. in water phase; c_B = concn. in C_6H_6 phase.



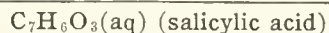
Activity coefficient in aqueous salt solutions at 298.1°K (1177) from (635, 1254)



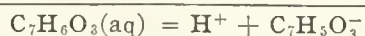
$$\Delta F_{298.1}^0 = 2\,151 \text{ (1177)}; \text{ solubility in aqueous salt solutions at } 298.1^\circ\text{K} \text{ (635, 1177, 1178, 1254)}$$



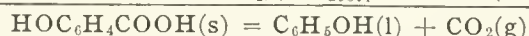
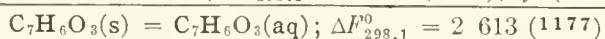
$$K_{298.1} = 6.61 \times 10^{-5}; \Delta F_{298.1}^0 = 5\,705 \text{ (1177)}; \text{ cf. (1344)}$$



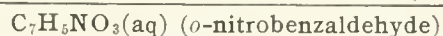
Activity coefficient in aqueous salt solutions at 298.1°K (1177) from (635)



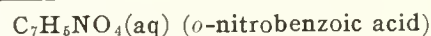
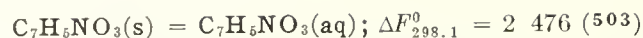
$$K_{298.1} = 1.06 \times 10^{-3}; \Delta F_{298.1}^0 = 4\,060 \text{ (1177)}; \text{ cf. (1344)}$$



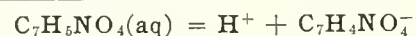
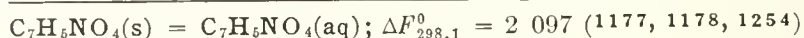
At $T = 476.1^\circ\text{K}$, 21 – 28% dissociated (64, 1101)



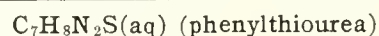
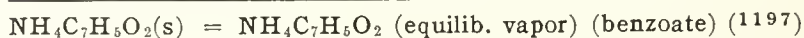
Activity coefficient in aqueous salt solutions at 298.1°K (1176) from (503)



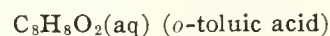
Activity coefficient in aqueous salt solutions at 298.1°K (1177) from (635, 1254)



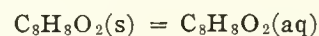
$$K_{298.1} = 6.12 \times 10^{-3}; \Delta F_{298.1}^0 = 3\,021 \text{ (1177)}; \text{ cf. (1344)}$$



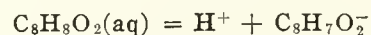
Activity coefficient in aqueous salt solutions at 293.1°K (1176) from (92, 1265)



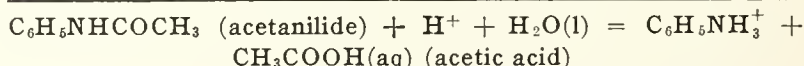
Activity coefficient in aqueous salt solutions at 298.1°K (1177) from (1265)



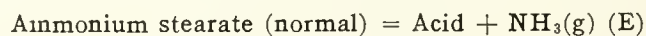
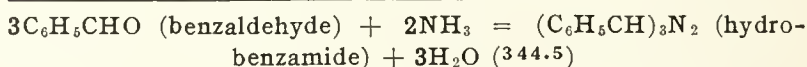
$$\Delta F_{298.1}^0 = 2\,881 \text{ (1177)}; \text{ solubility in } \text{MgSO}_4(\text{aq}) \text{ at } 298.1^\circ\text{K}; \text{ (1177, 1265)}$$



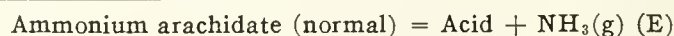
$$K_{298.1} = 1.30 \times 10^{-4}; \Delta F_{298.1}^0 = 5\,304 \text{ (1177)}; \text{ cf. (1344)}$$



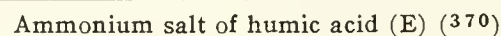
$$K_{373.1} = 950 \text{ (987)}; \text{ cf. (321)}$$



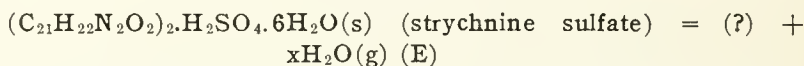
$$\text{At } 338.0^\circ\text{K}, P = 0.0367 \text{ (370)}$$



$$\text{At } 350.4^\circ\text{K}, P = 0.0532 \text{ (370)}$$

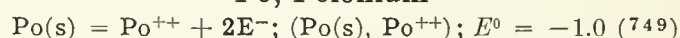


The ammonia pressure is proportional to the NH_3 content of the substance

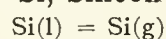


For maximum loss in weight at 298.1°K over H_2SO_4 , v . (916)

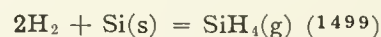
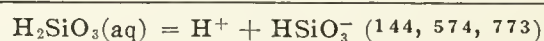
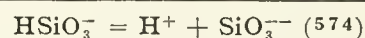
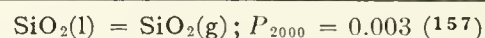
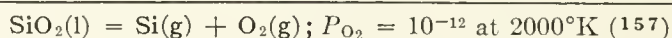
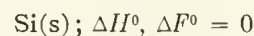
Po, Polonium



Si, Silicon

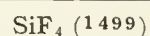


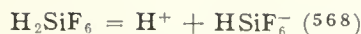
T	P	ΔH	Lit.
1 800–2 000	1	44 000–49 000	(157)



$$\log K = 8\,700/4.57T - 1.75 \log T + 2.18$$

T	P_{SiH_4}	P_{H_2}	T	P_{SiH_4}	P_{H_2}
453.1	0.0697	1.187	478.1	0.0342	1.116
473.1	0.0500	0.926	533.1	0.0500	1.213



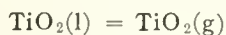


$$\Delta H_{298.1}^0 = -128\,100; \Delta S_{298.1}^0 = 48.27; \Delta F_{298.1}^0 = -113\,710 \text{ (833)}$$

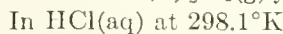
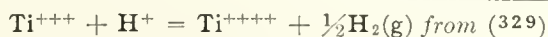
Ti, Titanium



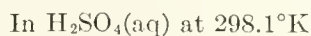
T	P	ΔH	Lit.
3 000–4 000	1	77 000–117 000	(157)



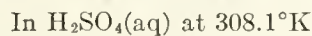
T	P	ΔH	Lit.
2 000	0.004		
2 500–3 000	1	63 000–77 000	(157)



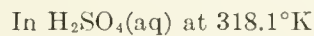
$m(\text{H}^+)$	$m(\text{Cl}^-)$	$m(\text{Ti}^{++++})$	$m(\text{Ti}^{+++})$	p_{H_2}	μ	K_m
0.9573	0.965	0.0073	0.0062	0.9592	1.048	1.196
.9573	.965	.0072	.0068	.9492	1.047	1.148
.9576	.965	.0074	.0061	.9684	1.048	1.226
1.925	1.930	.0049	.0130	.9605	2.025	0.194
1.925	1.930	.0048	.0131	.9605	2.025	0.186



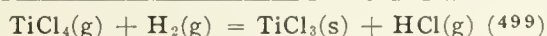
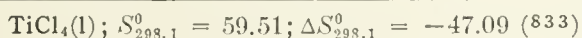
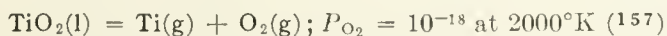
$m(\text{H}^+)$	$m(\text{SO}_4^{--})$	$m(\text{Ti}^{++++})$	$m(\text{Ti}^{+++})$	p_{H_2}	μ	K_m
0.9604	0.4825	0.0048	0.0091	0.9643	1.524	0.536
.9270	.4660	.0077	.0147	.9648	1.523	.548
.9604	.4825	.0047	.0091	.9671	1.524	.534
.9270	.4660	.0077	.0146	.9671	1.523	.559
.9896	.4911	.0033	.0061	.9389	1.531	.520
.9896	.4911	.0033	.0061	.9389	1.531	.518
.9896	.4911	.0033	.0060	.9406	1.531	.542
.9882	.4902	.0035	.0063	.9444	1.531	.548
.9899	.4911	.0031	.0063	.9617	1.530	.486
.9566	.4828	.0049	.0091	.9683	1.523	.551
.9569	.4825	.0049	.0090	.9683	1.523	.558
.9839	.4937	.0031	.0049	.6889	1.526	.553
.9835	.4937	.0035	.0045	.5175	1.527	.563
.9924	.4982	.0031	.0026	.3541	1.529	.693
.9982	.5007	.0027	.0017	.2446	1.529	.778
.9789	.4909	.0037	.0058	.8095	1.527	.523



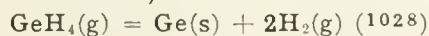
$m(\text{H}^+)$	% Ti as Ti^{++++}	p_{H_2}	K_m
0.9590	42.2	0.9408	0.740
.9590	42.8	.9408	.757
.9590	41.9	.9408	.730
.9590	41.8	.9408	.726
.9590	41.8	.9408	.726



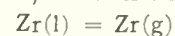
$m(\text{H}^+)$	% Ti as Ti^{++++}	p_{H_2}	K_m
0.9569	49.3	0.9342	0.982
.9573	49.8	.9461	1.008
.9569	49.8	.9461	1.008
.9573	49.9	.9474	1.013
.9573	49.4	.9487	0.993
.9573	49.6	.9487	1.001



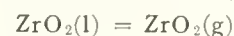
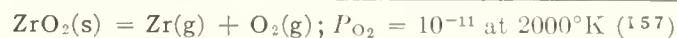
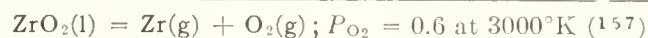
Ge, Germanium



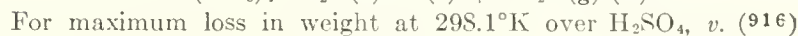
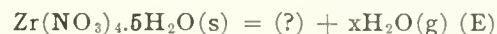
Zr, Zirconium



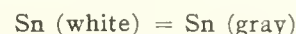
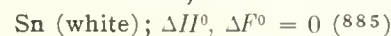
T	P	ΔH	Lit.
2 500–3 000	1	63 000–77 000	(157)



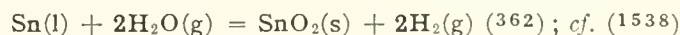
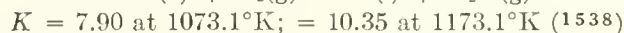
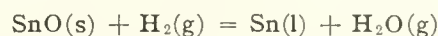
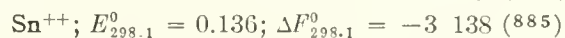
T	P	ΔH	Lit.
2 000	0.068		
3 000	0.021		
3 500–4 000	1	92 000–117 000	(157)



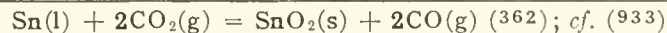
Sn, Tin



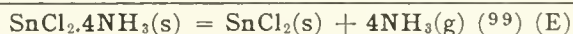
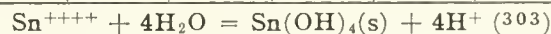
$$\Delta H_{273.1}^0 = 532; \Delta F^0 = 666 + 0.49T \ln T - 4.78T; \Delta S_{298.1}^0 = -1.94; \Delta F_{298.1}^0 = 9.5; (197, 198); \text{cf. (290–294, 300, 885, 988, 989)}$$



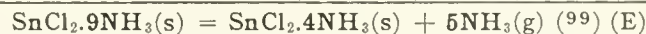
T	K	T	K	T	K
928	0.434	1044	0.240	1099	0.203
931	.377	1046	.240	1099	.193
971	.359	1082	.191	1169	.152
976	.333				



T	918	939	954	977	1 045	1 088
K	0.326	0.312	0.304	0.295	0.270	0.255



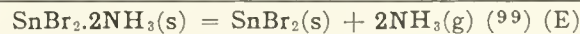
T	237.1	273.1	283.7	ΔH
P	0.0229	0.424	0.757	37 200



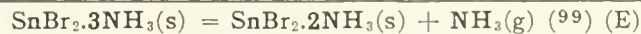
T	194.6	224.1	237.6	ΔH
P	0.0091	0.188	0.478	38 000



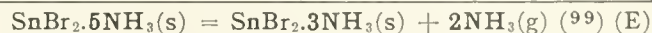
$$\Delta H_{298.1}^0 = -128\,010; \Delta S_{298.1}^0 = -49.66; \Delta F_{298.1}^0 = -113\,210 \text{ (833)}$$



T	353.1	370.1	383.6	ΔH
P	0.039	0.105	0.211	27 200



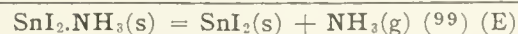
T	329.0	334.1	337.7	ΔH
P	0.0463	0.088	0.121	12 400



T	251.8	273.1	290.7	ΔH
P	0.017	0.1756	0.466	19 600



T	194.6	225.6	233.4	ΔH
P	0.018	0.2703	0.457	30 200



T	370.1	388.1	412.1	ΔH
P	0.0084	0.0108	0.066	16 000

$\text{SnI}_{2.2}\text{NH}_3(\text{s}) = \text{SnI}_{2.1}\text{NH}_3(\text{s}) + \text{NH}_3(\text{g})$ (99) (E)				
T	334.1	353.1	370.1	ΔH
P	0.025	0.063	0.153	13 300
$\text{SnI}_{2.3}\text{NH}_3(\text{s}) = \text{SnI}_{2.2}\text{NH}_3(\text{s}) + \text{NH}_3(\text{g})$ (99) (E)				
T	307.9	334.1	353.1	ΔH
P	0.028	0.196	0.503	11 900
$\text{SnI}_{2.5}\text{NH}_3(\text{s}) = \text{SnI}_{2.3}\text{NH}_3(\text{s}) + 2\text{NH}_3(\text{g})$ (99) (E)				
T	250.1	273.1	289.6	ΔH
P	0.0110	0.078	0.220	20 400
$\text{SnI}_{2.9}\text{NH}_3(\text{s}) = \text{SnI}_{2.5}\text{NH}_3(\text{s}) + 4\text{NH}_3(\text{g})$ (99) (E)				
T	194.6	217.1	227.1	ΔH
P	0.0067	0.074	0.155	31 600

Pb, Lead**Pb(g)**

$C_p = 4.97$; $\Delta F^0 = 51\,091 + 0.36T \ln T + 0.00176T^2 - 33.86T$;
 $\Delta F_{298.1}^0 = 41\,764$ (1189)

Pb(l)

$\Delta F^0 = 401 - 2.34T \ln T + 0.00176T^2 + 13.25T$; $\Delta F_{298.1}^0 = 533$
 (1189); $\Delta F_{600.5}^0 = 0$; $C_p = 7.67$ (1484); cf. (663, 765)

Pb(l) = Pb(g)

$\Delta F^0 = 50\,690 + 2.70T \ln T - 47.108T$; $\Delta F_{298.1}^0 = 41\,231$
 (1189) from (369, 510, 511, 512, 586, 664, 1233, 1234, 1274, 1506, 1501)

$\text{Pb(s)} (1189)$; $\Delta F^0 = 0$; $\Delta H^0 = 0$; $C_p = 5.33 + 0.00352t$

$\text{Pb(s)} = \text{Pb}$ (in het. amalg.); $E = 0.00552 + 0.0000137t$;
 $E_{298.1} = 0.00586$; $\Delta F_{298.1}^0 = -270$ (1189) from (256, 470); cf. (37, 188, 189, 193)

$\text{Pb(s)} = \text{Pb}$ (in amalg., $x_2 = 0.00697$); $E_{298.1} = 0.0140$; $\Delta F_{298.1}^0 = -646$ (1189) from (37, 188, 189, 862, 1220, 1395); $E = 0.0051 + 0.000233t$; $E_{298.1} = 0.0109$ (188, 189)

Pb⁺⁺

$E_{298.1}^0 = 0.122$; $\Delta F_{298.1}^0 = -5\,630$ (885). (Revised value)
 from (188, 189, 470, 477, 478, 598, 862); cf. (701); $E_{298.1}^0 = 0.1203$;
 $\Delta F_{298.1}^0 = -5\,551$ (1173)

Sn(s) + Pb⁺⁺ = Pb(s) + Sn⁺⁺

In SnClO_4 and PbClO_4 at 298.1°K (1089); cf. (885, 1283, 1284)

$\mu^{1/2}$	0.39	0.43	0.52	0.55
K	3.124 ± 0.034	2.979 ± 0.021	3.005 ± 0.020	2.956 ± 0.024

PbO (red)

$\Delta F_{298.1}^0 = -45\,050$ (1381); cf. (954); see Ishikawa and Shibata (674); if these authors used PbO(y) , then $\Delta F_{298.1}^0 = -45\,081$

Pb(s) + H₂O(l) = H₂(g) + PbO (red)

$E_{298.1}^0 = -0.2494$; $\Delta F_{298.1}^0 = 11\,510$ (1381)

Pb (in het. amalg.) + H₂O(l) = H₂(g) + PbO (red?)

$E^0 = -0.2579 + 0.000375(t - 25) - 0.0000035(t - 25)^2$; $\Delta F_{298.1}^0 = 11\,902$ (674)

PbO (yellow)

$C_p = 11.57$ (887); $= 11.25 + 0.0016T$ (1189.1) from (785, 786, 934, 1056, 1198, 1281); $\Delta F_{298.1}^0 = -44\,896$ (1189.1)

PbO (red) = PbO (yellow)

$\Delta F_{298.1}^0 = 160$ (1189.1); cf. (22, 495, 1272)

PbO. $\frac{1}{3}\text{H}_2\text{O(s)}$; $\Delta F_{298.1}^0 = -63\,520$ (1189.1)**PbO₂(s)**

$\Delta F_{298.1}^0 = -52\,070$ (1189.1); see also $\text{PbCl}_2(\text{s}) + 2\text{H}_2\text{O(l)} + \text{Cl}_2(\text{g})$

$\text{PbO}_2(\text{s}) = \text{PbO}_x(\text{s}) + \frac{1}{2}(2 - x)\text{O}_2(\text{g})$ (1002, 1205)

$\text{PbO}_2(\text{s}) + \text{H}_2(\text{g}) = \text{PbO (yellow?) + H}_2\text{O (in NaOH, 1N)}$

$E_{290.1}^0 = 1.078$ (495, 496, 497)

PbOH^+ ; $\Delta F_{298.1}^0 = -53\,440$ (1189.1)

HPbO_2^- ; $\Delta F_{298.1}^0 = -80\,602$ (1189.1)

$\text{PbO (red)} + \text{OH}^- = \text{HPbO}_2^-$

$K_{298.1} = 0.0402$; $\Delta F_{298.1}^0 = 1\,903$ (1189.1); cf. (22, 45, 83, 450, 494, 1025, 1207, 1272); for solubility in KOH solns., v. (1189.1)

$\text{PbO (yellow)} + \text{OH}^- = \text{HPbO}_2^-$

$K_{298.1} = 0.0531$; $\Delta F_{298.1}^0 = 1\,740$ (1189.1); for solubility in KOH solns., v. (1189.1)

$\text{PbO} \cdot \frac{1}{3}\text{H}_2\text{O(s)} + \text{OH}^- = \text{HPbO}_2^- + \frac{1}{3}\text{H}_2\text{O(l)}$

$K_{298.1} = 0.0780$; $\Delta F_{298.1}^0 = 1\,512$ (1189.1); cf. (494, 1269, 1551); for solubility in KOH solns., v. (1189.1)

$\text{Pb(OH)}_2(\text{aq})$; $\Delta F_{298.1}^0 = -96\,888$ (1189.1)

$\text{PbO} \cdot \frac{1}{3}\text{H}_2\text{O(s)} + \frac{2}{3}\text{H}_2\text{O(l)} = \text{Pb(OH)}_2(\text{aq})$

$K_{291.1} = 0.00045$ (1147)

$\text{Pb(OH)}_2(\text{aq}) = \text{PbOH}^+ + \text{OH}^-$

$K_{291.1} = 4 \times 10^{-6}$ (1147); $\Delta H = 1\,000$; $K_{298.1} = 4.2 \times 10^{-5}$;
 $\Delta F_{298.1}^0 = 5\,980$ (1189.1)

$\text{Pb(OH)}_2(\text{aq}) = \text{H}^+ + \text{HPbO}_2^-$

$K_{291.1} = 1.47 \times 10^{-12}$ (estimated); $K_{298.1} = 1.2 \times 10^{-12}$; $\Delta H = 6\,000$; $\Delta F_{298.1}^0 = 16\,260$ (1189.1); cf. (83)

$\text{PbCl}_2(\text{l}) + \text{H}_2(\text{g}) = \text{Pb(l)} + 2\text{HCl(g)}$ (40, 1109)

$\text{Sn(l)} + \text{PbCl}_2(\text{l}) = \text{Pb(l)} + \text{SnCl}_2(\text{l})$ (912)

PbCl₂(s)

$E_{298.1}^0 = 1.6264$; $\Delta F_{298.1}^0 = -75\,056 \pm 10$ (1189) from (256, 470); cf. (14, 193, 530, 792)

$\text{PbCl}_2(\text{s}) + 2\text{H}_2\text{O(l)} + \text{Cl}_2(\text{g}) = \text{PbO}_2(\text{s}) + 4\text{HCl(aq)}$

$K_{298.1} = 2.8 \times 10^{-8}$ (1518); $K_{298.1} = 3.22 \times 10^{-9}$; $\Delta F_{298.1}^0 = 11\,590$ (1189) (gives for PbO_2 , q.v., $\Delta F_{298.1}^0 = -51\,118$)

$\text{PbCl}_2 \cdot x\text{NH}_3 = (?) + x\text{NH}_3(\text{g})$ (E)

The large degree of supersaturation of the solid solutions reduces the pressure according to (380) and hence values of (98) are uncertain

$\text{PbCl}_2 \cdot \text{NH}_3(\text{s}) = \text{PbCl}_2(\text{s}) + \text{NH}_3(\text{g})$ (98) (E)

T	P	T	P
351.56	0.0174	372.7	0.220
353.24	0.024	$\Delta H = 13\,300$	

$\text{PbCl}_2 \cdot \frac{1}{2}\text{NH}_3(\text{s}) = \text{PbCl}_2 \cdot \text{NH}_3(\text{s}) + \frac{1}{2}\text{NH}_3(\text{g})$ (98) (E)

$\Delta H = 11\,300$; Ephraim (380) observed an intermediate stage in the decomposition

T	P	T	P
294.8	0.021	319.1	0.351

$\text{PbCl}_2 \cdot 2\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (98, 380) (E)

$\Delta H = 12\,400x$ (380); $= 11\,000x$ (98)

T	P	T	P
293.6*	0.0432	341.6	0.768
307.75*	.1849	344.6	.816
319.2*	.455	345.1	.829
324.1	.345	345.6	.941
332.6	.487	353.1	1.026
333.1	.529		

* From (98); all other values from (380).

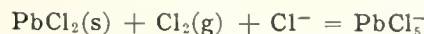
$\text{PbCl}_2 \cdot 3\frac{1}{4}\text{NH}_3(\text{s}) = \text{PbCl}_2 \cdot 2\text{NH}_3(\text{s}) + 1\frac{1}{4}\text{NH}_3(\text{g})$ (98) (E)

T	P	T	P
251.9	0.0449	273.1	0.474
262.0	0.1489	$\Delta H = 11\,750$	

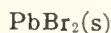
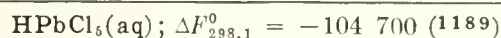
$\text{PbCl}_2 \cdot 8\text{NH}_3(\text{s}) = \text{PbCl}_2 \cdot 3\frac{1}{4}\text{NH}_3(\text{s}) + 4\frac{3}{4}\text{NH}_3(\text{g})$ (98) (E)

T	P	T	P
194.6	0.0024	251.9	0.445
223.1	0.0350	$\Delta H = 38\,950$	

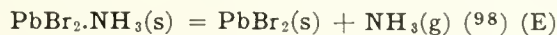
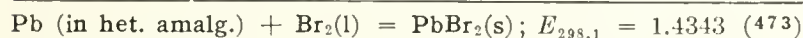
PbCl_5^- ; $\Delta F_{298.1}^0 = -104\,700$ (1189)



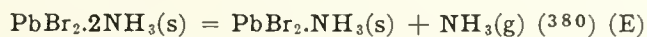
$$K_{298.1} = 0.055 \text{ (1518)}; \Delta F_{298.1}^0 = -31\,367 \text{ (1189)}$$



$$E_{298.1}^0 = 1.3449; \Delta F_{298.1}^0 = -62\,063 \pm 20 \text{ (1189) from (470, 1173); cf. (168, 473, 792, 834)}$$

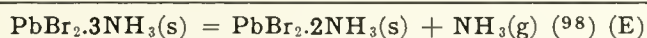


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
383.7	0.0220	429.7	0.2009
412.5	0.1012	457.45	0.604
$\Delta H = 15\,600$			

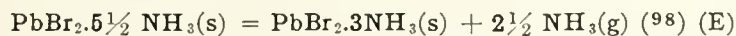


<i>T</i>	<i>P</i> *	<i>T</i>	<i>P</i> *
272.1	0.059	326.6	0.599
295.1	.176	333.1	.738
305.1	.276	335.1	.789
315.1	.393	339.6	.897
325.1	.566	343.1	.995
$\Delta H = 12\,100$			

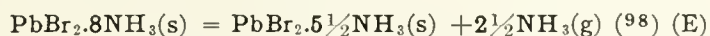
* Ephraim observes various degrees of supersaturation. In such cases the lower pressure values which Biltz and Fischer (98) observed for the compound are given.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
244.4	0.0372	291.6	0.784
273.1	0.2480	$\Delta H = 9\,500$	



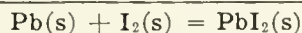
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
228.1	0.022	273.1	0.568
245.1	0.0946	$\Delta H = 22\,500$	



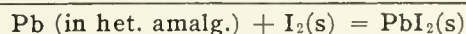
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
221.1	0.036	262.2	0.921
243.7	0.266	$\Delta H = 20\,500$	



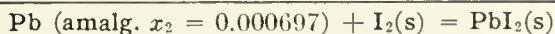
$$E_{298.1}^0 = 0.89949; \Delta F_{298.1}^0 = -41\,510 \pm 5 \text{ (470); cf. (789.5)}$$



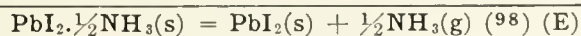
$$E_{298.1} = 0.8983 \text{ in } 0.5N \text{ KI}; = 0.8968 \text{ in } 0.1N \text{ KI (789.5)}; = 0.89949; E_{273.1} = 0.90012 \text{ (470)}$$



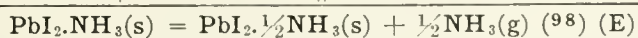
$$E_{298.1} = 0.89363; E_{273.1} = 0.89460 \text{ (470)}$$



$$E_{298.1} = 0.8843 \text{ in } 0.5N \text{ KI (interpolated)}; = 0.8828 \text{ in } 0.1N \text{ KI (interpolated) (789.5)}$$



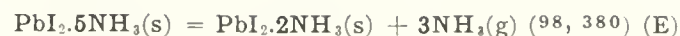
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
383.7	0.0636	429.7	0.4756
388.0	0.0840	$\Delta H = 7\,200$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
329.0	0.014	384.1	0.398
353.3	0.093	$\Delta H = 6\,600$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
289.6	0.0180	329.0	0.417
307.55	0.1470	$\Delta H = 11\,300$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
242.2	0.0129	289.6	0.5099
258.1	.053	290.2	.530
270.1	.132*	291.6	.546
270.1	.136	295.1	.651
273.1	.161	300.1	.825
286.1	.408	303.6	.938

First decomposition product (380)

315.6	0.164	343.1	0.658
320.1	.211	351.1	.893
329.1	.362	354.1	.980
330.6	.382		

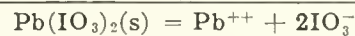
Second decomposition product (380)

356.1	0.084	399.6	0.605
373.6	.184	408.6	.804
388.6	.378		

* Interpolated value from (98); all others from (380). The yellow $\text{PbI}_2 \cdot 5\text{NH}_3$ of Biltz and Fischer (98) is very likely identical with the white $\text{PbI}_2 \cdot 4\text{NH}_3$ of Ephraim (380). Biltz and Fischer studied the decomposition; Ephraim the synthesis.



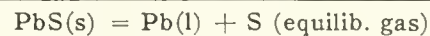
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
194.6	0.0079	239.1	0.557
216.6	.0852	$\Delta H = 23\,400$	



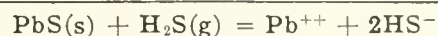
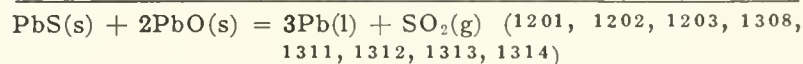
$$K_{298.1} = 5.92 \times 10^{-12}; \Delta F_{298.1}^0 = 16\,690$$



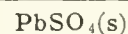
$$\Delta F_{298.1}^0 = 18\,000 \text{ (1189) from (615)}; C_p = 12.20 \text{ (887)}; \text{cf. (363)}$$



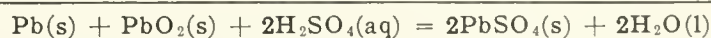
$$P_{961} = 0.0026 \text{ (1307)}; \text{cf. (456)}$$



$$\log K_{298.1} = -18.88; \Delta F_{298.1}^0 = 25\,770 \text{ (1189) from (615)}$$

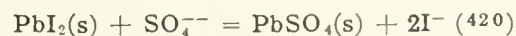


$$\Delta F_{298.1}^0 = -176\,500 \text{ (1189)}; C_p = 25.07 \text{ (786)}$$



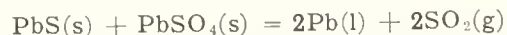
$$E_{298.1}^0 = 2.021 \text{ (347)}; \Delta F_{298.1}^0 = -93\,270 \text{ (366)}$$

<i>m</i> (H ₂ SO ₄)	γ (H ₂ SO ₄)	α (H ₂ O)	<i>E</i> (366)	<i>E</i> (347)	$\Delta F_{298.1}^0$
2.687	0.158	0.879	1.994	1.953	2.021
2.541	.155	.888	1.988	1.947	2.021
0.4961	.178	.982	1.866	1.828	2.053
0.05306	.388	.998	1.735	1.727	2.024



$$K_{298.1} = 0.62 \text{ (approx.)}; \Delta F_{298.1}^0 = 892; \text{solubility at } 298.1^\circ\text{K}$$

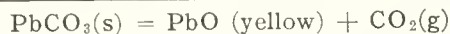
<i>C</i> (Na ₂ SO ₄)	<i>C</i> (NaI)	μ_c	<i>K_c</i>
0.00182	0.02288	0.0283	0.5742
.00214	.02520	.0316	.5932
.00564	.04158	.0585	.6136
.00577	.04151	.0588	.5968
.0089	.0523	.0790	.6140
.0090	.0521	.0791	.6042
.00946	.05275	.0811	.5870
.00940	.05265	.0809	.5896
.0178	.0684	.1218	.5256
.0177	.0687	.1218	.5342
.0406	.0968	.2186	.4616
.04101	.1009	.2239	.4420
.04116	.1008	.2243	.4400



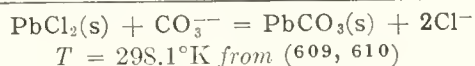
$\Delta H_{298.1} = 96\,550$ (by combination of calorimetric data); $= 95\,230$ (by addition of ΔH 's obtained by slopes of two other equations); $\Delta F_{298.1}^0 = 67\,900$ (by addition); $= 71\,650$ (by use of entropies) (887) from (636, 1201, 1202, 1203, 1308, 1311, 1312, 1313)



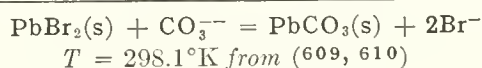
$C_p = 25.95$ (785, 786); $\Delta F_{298.1}^0 = -149\,000$ (1189.1) from (306, 307)



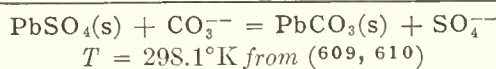
$\Delta F^0 = 21\,140 + 7.38T \ln T - 0.00355T^2 + 0.00000031T^3 - 81.82T$ (range 457 to 558°K), from $\Delta H_{290.1} = 19\,280$; graph gives $\Delta H = 20\,700$; $\Delta F_{298.1}^0 = 8\,970$ (1189.1) from (306, 307). $\Delta H = 24\,830$; $\Delta F_{298.1}^0 = 11\,380$ (274)



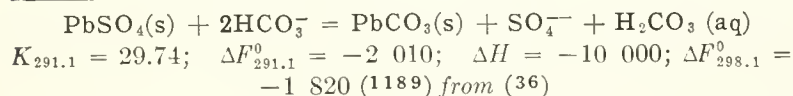
$C(\text{NaCl})$	$C(\text{Na}_2\text{CO}_3)$	μ_c	K_c
2.277	0.00635	2.283	817
3.674	.01325	3.687	1 020



$C(\text{NaBr})$	$C(\text{Na}_2\text{CO}_3)$	μ_c	K_c
1.682	0.0100	1.692	283
2.262	.0138	2.274	371



$C(\text{Na}_2\text{SO}_4)$	$C(\text{Na}_2\text{CO}_3)$	μ_c	K_c
0.2103	0.0025	0.6384	84.2
.4213	.00425	1.277	99.2
.6319	.00635	1.915	99.6
.8425	.0085	2.554	99.2



$C(\text{SO}_4^{--})$	$C(\text{HCO}_3^-)$	$C(\text{H}_2\text{CO}_3)$	μ_c	$K_{c,291.1}$
0.0461	0.0061	0.0451	0.145	28.43
.0468	.0061	.0449	.147	28.87
.0476	.0036	.0164	.196	30.82
.0473	.0055	.0378	.147	30.30



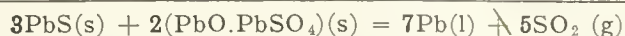
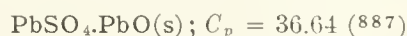
For the salt which resulted from the anhydrous salt through absorption of water from the air:

T	Rel. P^*	T	Rel. P^*
288.1	0.00043	294.5	0.00050
291.7	.00047	294.6	.00051
293.5	.00047		

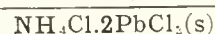
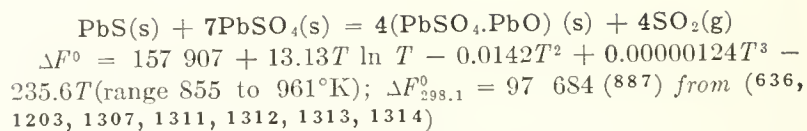
For the salt crystallized out of solution. The pressure decrease becomes greater after the loss of 2 moles of water. At $\frac{1}{2}$ mole of water, the pressure becomes a minimum:

T	Rel. P^*	T	Rel. P^*
288.0	0.00059	294.0	0.00050
291.7	0.00056	294.5	.00056

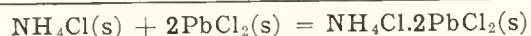
* "Relative pressure;" i.e., the ratio of the loss in weight of the salt to the loss in weight of pure water.



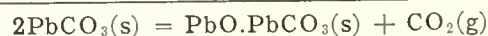
$\Delta F^0 = 267\,970 + 30.7T \ln T - 0.0177T^2 + 0.00000155T^3 - 435.5T$ (range 985 to 1063°K); $\Delta F_{298.1}^0 = 188\,757$ (887) from (1201, 1202, 1203)



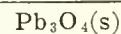
$\Delta F_{298.1}^0 = -200\,740$ (1189)



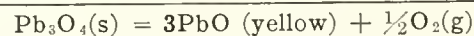
$E_{298.1}^0 = 0.0307$; $\Delta F_{298.1}^0 = -2\,834$; $\Delta F_{291.1}^0 = -2\,815$; $\Delta F_{373.1}^0 = -3\,195$ (193)



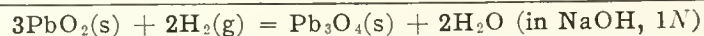
$\Delta F^0 = 17\,000 + 16.99T \ln T - 0.00355T^2 + 0.00000031T^3 - 74.96T$ (range 489 to 541°K); $\Delta F_{298.1}^0 = 6\,883$ (1189) from (274); cf. (275)



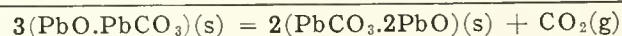
$C_p = 35.70 + 0.0095T$ (1189) from (1006, 1106, 1281); $\Delta F_{298.1}^0 = -147\,342$ (1189)



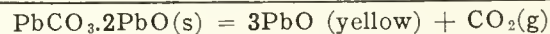
$\Delta F^0 = 19\,179 - 1.30T \ln T + 0.0021T^2 - 15.109T$ (range 718 to 880°K); $\Delta F_{298.1}^0 = 12\,654$ (1189) from (1205); cf. (495, 496, 497, 998-1001, 1006)



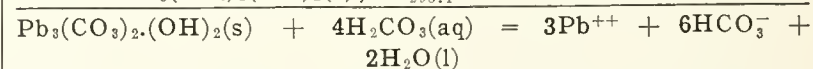
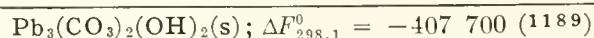
$E_{290.1} = 1.135$ (495, 496, 487)



$\Delta F^0 = 45\,000 + 16.99T \ln T - 0.00355T^2 + 0.00000031T^3 - 119.0T$ (range 541 to 614°K); $\Delta F_{298.1}^0 = 21\,750$ (1189.1) from (274)

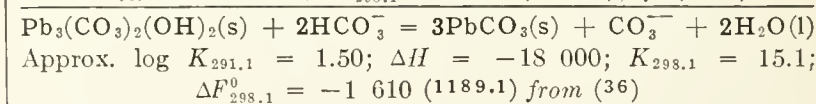
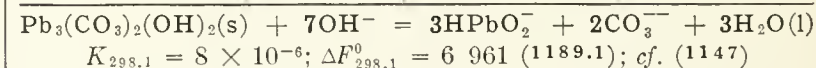


$\Delta F^0 = 25\,700 + 16.99T \ln T - 0.00355T^2 + 0.00000031T^3 - 83.80T$ (range 611 to 678°K); $\Delta F_{298.1}^0 = 12\,946$ (1189.1) from (274)

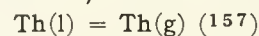


$\log p.f._{291.1} = 2.5$; $\Delta F_{291.1}^0 = 30\,020$; $\Delta H = -23\,160$; $\Delta F_{298.1}^0 = 31\,330$ (1191) from (1147); cf. (564)

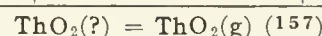
$m(\text{Pb})$	$m(\text{H}_2\text{CO}_3)$	$(\log 1/K_m^{1/6})$	$\mu^{1/2}$
0.000008	(?)		
.000029	0.000064	3.0325	0.009
.000034	.000123	2.5991	.010
.000040	.000328	2.7193	.011
.000048	.000592	2.7627	.012
.000053	.000988	2.7825	.013
.000076	.002400	2.7541	.015



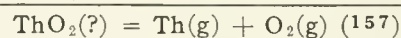
Th, Thorium



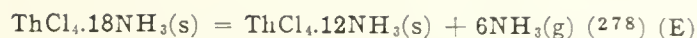
T	P	ΔH
2 000-2 500	1	49 000-63 000



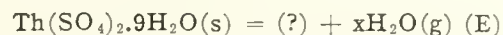
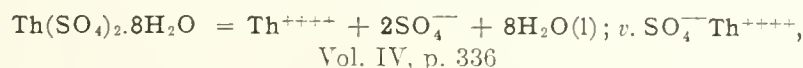
T	P	ΔH
2 000	0.064	
3 000	0.021	
3 500-3 800	1	91 000-100 000



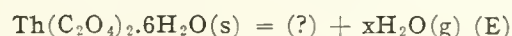
T	P_{O_2}	T	P_{O_2}
2 000	10^{-27}	3 000	0.066



T	P	T	P
250.6	0.324	273.1	1.356
263.1	0.737	281.1	2.145
$\Delta H = 52 \ 980$			

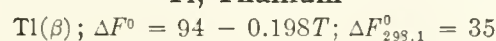


Maximum loss in weight at 298.1°K over H_2SO_4 (916); for the reaction, $\text{Th}(\text{SO}_4)_2 \cdot 8\text{H}_2\text{O} = \text{Th}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O} + 4\text{H}_2\text{O}$, Koppel (787) gives $\log P' = \log P - 3381/4.606T + 2.3286$. $P = 0.04154$ at $T = 303.1^\circ\text{K}$ and $P = 0.08044$ at $T = 315.1^\circ\text{K}$

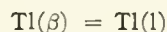
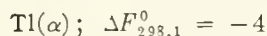
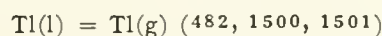


Maximum loss in weight at 298.1°K over H_2SO_4 (916). The water is lost continuously at first, then suddenly at the change to dihydrate. This change to the dihydrate is the same for the crystalline and microcrystalline form, whence the two forms are identical (594)

Tl, Thallium

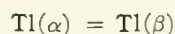


$$\Delta F^0 = 389 - 1.85T \ln T + 10.940T; \Delta F_{298.1}^0 = 468; \Delta H_{298.1}^0 = 900$$

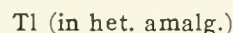


$$\Delta F = 255 - 1.85T \ln T + 11.138T; \Delta F_{298.1}^0 = 433; \Delta H_{298.1}^0 = 551;$$

$$\Delta F_{376.6}^0 = 0 \quad (1223); \Delta H_{576.6} = 1 \ 470 \quad (1230)$$

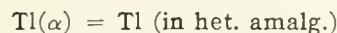


$$\Delta F^0 = 39 - 1.85T; \Delta F_{298.1}^0 = 39; \Delta F_{508.4}^0 = 0 \quad (1223)$$



$$C_p = 8.3 \quad (883, 885); \Delta F = -614 - 1.95T \ln T + 12.985T;$$

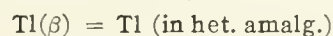
$$\Delta F_{298.1} = -55; \Delta H_{298.1} = -33 \quad (470)$$



$$E_{291.1} = 0.00208; E_{298.1} = 0.0022 \quad (1223); = 0.0026 \quad (1218);$$

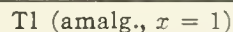
$$= 0.0028 \quad (732); = 0.0027; dE/dt = 0.000020 \quad (470). \Delta F^0 = -614$$

$$- 1.95T \ln T + 12.998T; \Delta F_{298.1} = -51; \Delta H_{298.1} = -33 \quad (470).$$



$$\Delta F = -708 - 1.95T \ln T + 13.183T; \Delta F_{298.1} = -90; \Delta H_{298.1}$$

$$= -127; E_{291.1} = 0.0038 \text{ from } (1223)$$



$$\Delta F^0 = -1 \ 897 - 3.85T \ln T + 25.760T; \Delta F_{298.1}^0 = -757; \Delta H_{298.1}^0$$

$$= -749$$

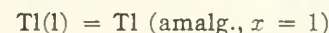
x_{Tl}	$x_{\text{Tl}}/x_{\text{Hg}}$	$(a/x)_{\text{Tl}(293.1)}$ (885)	$(a/x)_{\text{Hg}(293.1)}$
0	0	1	1
0.005	0.00502	1.06	0.9998
0.01	0.0101	1.15	0.999
0.05	0.0526	1.80	0.986
0.1	0.111	2.84	0.950
0.2	0.250	4.98	0.866
0.3	0.428	6.60	0.790
0.4	0.667	7.57	0.734
0.5	1.000	7.98	0.704

Tl (amalg.)—Continued

x_{Tl}	$x_{\text{Tl}}/x_{\text{Hg}}$	$(a/x)_{\text{Tl}(576.1)}$	$(a/x)_{\text{Hg } 576.1}$
0		1	1
0.10		1.53	0.98
0.20		1.86	0.95
0.30		2.05	0.92
0.40		2.17	0.89
0.50		2.23	0.87
0.60		2.28	0.85
0.70		2.30	0.83
0.80		2.31	0.82
(1.00)		(2.32)	(0.80)

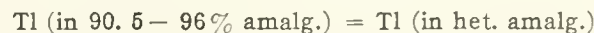
x_{Tl}	$\bar{L}_{\text{Tl}(303.1)}$	$\bar{L}_{\text{Hg}(303.1)}$
0.0000	0	0.0
0.0250	212	— 3.1
0.0500	413	— 10.2
0.0863	671	— 28.1
0.1000	750	— 37.2
0.1070	800	— 41.8
0.1500	1 013	— 75.8
0.2000	1 195	— 112
0.2500	1 324	— 144
0.3000	1 415	— 176
0.3500	1 478	— 207
0.4000	1 520	— 232
1.000 (extrapolated)	1 640	
Tl (s, satd. with Hg)	805	

x_{Tl}	$C_p \text{Hg}(303.1)$	$\bar{C}_p \text{Tl}(303.1)$
0.00	6.70	10.20
0.05	6.72	9.81
0.10	6.75	9.54
0.15	6.80	9.15
0.20	6.85	8.82
0.25	6.93	8.62
0.30	6.97	8.50
0.35	7.02	8.40
0.40	7.05	8.34
1.00 (extrapolated)		8.2



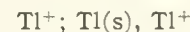
$$\Delta F^0 = -2 \ 246 - 2.0T \ln T + 14.82T; \Delta F_{298.1}^0 = -1 \ 225; \Delta H_{298.1}^0$$

$$= -1 \ 650 \text{ from } (883, 885) \text{ from } (623, 1218)$$



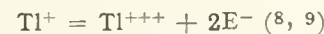
$$E_{291.1} = 0.0013 \quad (1223); \Delta F = -614 - 1.95T \ln T + 13.069T;$$

$$\Delta F_{298.1} = -30; \Delta H_{298.1} = -33$$

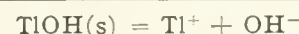
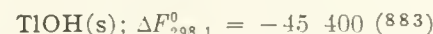


$$E_{298.1}^0 = 0.3363; \Delta F_{298.1}^0 = -7 \ 760 \quad (883) \text{ from } (470); \text{cf. } (9, 186,$$

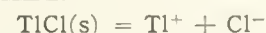
$$732, 803, 1061, 1218, 1348, 1413)$$



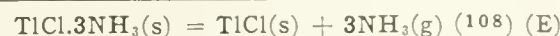
$$\text{Grube and Hermann } (520) \text{ give Pt, Tl}^+, \text{Tl}^{+++}, E_{291.1}^0 = -1.211$$



$$m_{\pm} \quad (298.1) = 1.70 \quad (42); \Delta F_{298.1}^0 = 190 \quad (885)$$



$$K_{298.1} = 2.78 \times 10^{-4}; \Delta F_{298.1}^0 = 5 \ 086 \quad (1192)$$



T	P^*	T	P^*
194.1	0.050	223.1	0.382
213.1	0.205	$\Delta H = \text{ca. } 21 \ 300$	

* The pressure hardly differs from that of pure NH_3 .

$\text{TiCl}_3 \cdot 3\text{NH}_3(\text{s}) = \text{Solid solution} + x\text{NH}_3(\text{g})$ (395) (E)

T	P	T	P
294.6	0.032	350.6	0.316
307.1	0.070	374.1	0.905
327.1	0.142	376.1	1.000 (extrap.)
$\Delta H = 13\ 400\text{x}$			

$\text{TiBr}(\text{s}); \Delta F_{298.1}^0 = -39\ 770$

$\text{TiBr}(\text{s}) = \text{Ti}^+ + \text{Br}^-; \Delta F_{298.1}^0 = 7\ 420$ (774)

$\text{TiCl}(\text{s}) + \text{Br}^- = \text{TiBr}(\text{s}) + \text{Cl}^-$ (505)

c (KCl or KBr)	$E_{298.1}$	c (KCl or KBr)	$E_{298.1}$
0.025	0.0958	0.1	0.1007
0.05	0.0991	0.2	0.1013
$\Delta F_{298.1}^0 = -2\ 340$			

$\text{TiBr} \cdot 3\text{NH}_3(\text{s}) = \text{TiBr}(\text{s}) + 3\text{NH}_3(\text{g})$ (E)

$P_{213.1} = 0.211; P_{223.1} = 0.378; \Delta H = \text{ca. } 21\ 300$ (395)

$\text{TiCl}(\text{s}) + \text{BrO}_3^- = \text{TiBrO}_3(\text{s}) + \text{Cl}^-$

At 312.85°K, $K_c = 1.246$ and $\Delta F^0 = -137$ (1077)

$\text{TiH}(\text{s}); \Delta F_{298.1}^0 = -30\ 020$

$\text{TiH}(\text{s}) = \text{Ti}^+ + \text{I}^-$

$\Delta F_{298.1}^0 = 9\ 883$ from $s_c = 0.000243$, interpolated from conductivity (774); $\Delta F_{298.1}^0 = 9\ 933$ from $s_c = 0.0002352$; at 273.1°K, $s_c = 0.0000587$ (732)

$\text{TiH} \cdot 3\text{NH}_3(\text{s}) = \text{TiH}(\text{s}) + 3\text{NH}_3(\text{g})$ (107) (E)

T	P^*	T	P^*
194.1	0.050	223.1	0.361
213.1	0.209	$\Delta H = \text{ca. } 21\ 300$	

* The pressure hardly differs from that of pure NH_3 .

$\text{TiCl}(\text{s}) + \text{CNS}^- = \text{TiCNS}(\text{s}) + \text{Cl}^-$ (772)

T	$c(\text{KCl} + \text{KCNS})$	K_c
273.9	0.10	1.736
293.1	0.10	1.241
313.0	0.10	0.850

$K_{298.1} = 1.13; \Delta F_{298.1}^0 = -74$ (772); at 298.1°K, $K_c = 1.112$ and $\Delta F^0 = -63$ from (1075); at 312.85°K, $K_c = 0.841$ and $\Delta F^0 = 107$ from (1077)

$\text{TiBrO}_3(\text{s}) + \text{CNS}^- = \text{TiCNS}(\text{s}) + \text{BrO}_3^-$

At 312.85°K, $K_c = 0.677$ and $\Delta F^0 = 243$ from (1077)

$\text{Ti}_2\text{O}(\text{s}); \Delta F_{298.1}^0 = -32\ 410$ (885)

$2\text{TiOH}(\text{s}) = \text{Ti}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{g})$ (42) (E)

$\Delta F_{298.1}^0 = 3\ 880$ (885)

T	P	T	P
319.4	0.017	378.5	0.214
344.6	0.030	383.7	0.279
352.2	0.055	389.6	0.367
356.3	0.070	395.3	0.479
362.6	0.096	403.1	0.670
364.9	0.109	408.8	0.886
370.4	0.145	413.1	1.013
374.7	0.178	$\Delta H = 15\ 200$	

$2\text{TiClO}_3(\text{s}) + \text{SO}_4^{--} = \text{Ti}_2\text{SO}_4(\text{s}) + 2\text{ClO}_3^-$

At 293.1°K, $K_c = 0.164$ and $\Delta F^0 = 1\ 055$ from (1078)

$\text{Ti}_2(\text{SO}_4)_3 \cdot 10\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (395) (E)

T	P	T	P
333.1	0.228	373.1	1.013
348.1	0.408	$\Delta H = 13\ 300\text{x}$	

Zn, Zinc

$\text{Zn}(\text{g}); C_p = 5.0$; see $\text{Zn}(\text{s}) = \text{Zn}(\text{g})$

$\text{Zn}(\text{l}); C_p = 7.24$ (166); see $\text{Zn}(\text{s}) = \text{Zn}(\text{l})$

$\text{Zn}(\text{l}) = \text{Zn}(\text{g})$

$\Delta F^0 = 30\ 540 + 2.24T \ln T - 41.760T$; $\Delta F_{298.1}^0 = 21\ 887$ (936)
from (166, 365, 511, 616, 617, 1233, 1234, 1556)

$\text{Zn}(\text{s}) = \text{Zn}(\text{g})$

$\Delta F^0 = 31\ 515 + 0.10T \ln T + 0.0015T^2 - 29.932T$; $\Delta F_{298.1}^0 = 22\ 885$ (936) from (368)

$\text{Zn}(\text{s}); \Delta F^0, \Delta H^0 = 0; C_p = 5.10 + 0.003T$ (365)

$\text{Zn}(\text{s}) = \text{Zn}(\text{l})$

$\Delta F^0 = 975 - 2.14T \ln T + 0.0015T^2 + 11.828T$; $\Delta F_{298.1}^0 = 998$ (936) from (492, 511, 618, 663, 971, 1131, 1556)

Zn^{++}

$E_{298.1}^0 = 0.7581$; $\Delta F_{298.1}^0 = -17\ 492$ (885) from (648)

$\text{ZnO}(\text{s})$

$C_p = 9.96 + 0.00298T - 0.000000387T^2$ (940) from (322.5)

$\Delta F_{298.1}^0 = -75\ 720$; $\Delta S_{298.1}^0 = -23.62$ (940); cf. (938)

$\text{ZnO}(\text{s}) + \text{H}_2(\text{g}) = \text{Zn}(\text{l}) + \text{H}_2\text{O}(\text{g})$ (491)

$\text{ZnO}(\text{s}) + \text{C} = \text{Zn}(\text{g}) + \text{CO}(\text{g})$ (137, 842)

$\text{ZnO}(\text{s}) + \text{CO}(\text{g}) = \text{Zn}(\text{g}) + \text{CO}_2(\text{g})$

$\Delta F^0 = 47\ 290 + 4.46T \ln T - 0.00156T^2 - 0.0000002455T^3 - 60.305T$ (range 825 to 1120°K); $\Delta F_{298.1}^0 = 36\ 855$ (941); cf. (137, 459, 842, 1097)

$\text{Zn}^{++} + \text{H}_2\text{O}(\text{l}) = \text{H}^+ + \text{ZnOH}^+$

In ZnCl_2 (aq) (800)

c	% Hydrolysis at 358.6°K	% Hydrolysis at 373.1°K
0.00392		0.137
.0157	0.0368	.0760
.125	.0421	.0835

In ZnSO_4 (aq) at 373.1°K (800)

c	% Hydrolysis
0.00392	0.110
.0157	.0416
.065	.0244

In $\text{Zn}(\text{NO}_3)_2$ (aq) (800)

c	% Hydrolysis at 358.6°K	% Hydrolysis at 373.1°K
0.00392	0.0421	0.0784
.0157		.0470
.125	.0242	.0309

$\text{Zn}(\text{OH})_2(\text{s}) + 2\text{OH}^- = \text{ZnO}_2^{--} + 2\text{H}_2\text{O}(\text{l}); K = 180$ (1551)

$\text{Zn}(\text{OH})_2(\text{s}) + \text{OH}^- = \text{ZnO}_2\text{H}^- + \text{H}_2\text{O}(\text{l})$

At 298.1°K (1551); cf. (1027)

$c(\text{NaOH})$	$c(\text{Zn})$	$c(\text{NaOH})$	$c(\text{Zn})$
0.2636	0.00311	0.5414	0.0129
.3871	.0057	.9280	.0425

$\text{Zn}(\text{OH})_2$ (aq) = $\text{H}^+ + \text{ZnO}_2\text{H}^-$

$K = >0.5 \times 10^{-12}$ (1360); cf. (763, 1027)

$\text{ZnCl}_2(\text{l}) + \text{H}_2(\text{g}) = \text{Zn}(\text{l}) + 2\text{HCl}(\text{g})$ (40)

ZnCl_2 . lowest hydrate = $\text{ZnCl}_2(\text{s}) + \text{aq}$ (E)

$P_{298.1} = 0.00112$; $P_{323.1} = 0.00288$ (70)

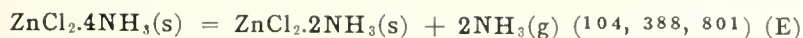
$\text{ZnCl}_2 \cdot \text{NH}_3(\text{s}) = \text{ZnCl}_2(\text{s}) + \text{NH}_3(\text{g})$ (E)

$P_{489.1} = 0.0088$ (801); $P_{703.1} = 0.132$ (extrap.); $\Delta H = 25\ 000$ (104)

$\text{ZnCl}_2 \cdot 2\text{NH}_3(\text{s}) = \text{ZnCl}_2 \cdot \text{NH}_3(\text{s}) + \text{NH}_3(\text{g})$ (104, 801) (E)

T	P	T	P
400.6	0.000061	483.9	0.039
429.1	0.00186	489.1*	0.057
457.6	0.00667	$\Delta H = 19\ 200$	

* From (801); all other values from (104).

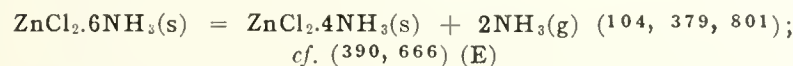


<i>T</i>	<i>P</i> *	<i>T</i>	<i>P</i> *
292.8	0.0155	351.1†	0.5291
308.0	0.0406	353.3	0.5554
327.1	0.132	365.1‡	0.961
338.2	0.2635	$\Delta H = 23\,640$	

* Isambert (666) found pressures a little higher.

† From (801).

‡ From (388); all other values from (104).



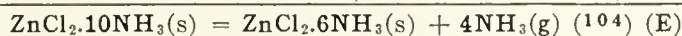
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
260.1	0.008	318.1	0.483
273.1	0.029	319.9*	0.5095
283.1	0.059	323.1	0.630
290.2*	0.0939	326.1	0.717
292.1	0.108	329.1	0.837
296.1*	0.132	330.6	0.897
300.1	0.172	333.1	1.009
308.0*	0.2731	334.4	1.054
312.1	0.353	351.1†	2.150

* From (104). † From (801); all other values from (379).

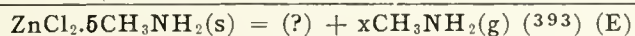
The values of (666) and (390) show good agreement with the above.

According to Ephraim (388), the decomposition goes first to NH_3 content of 4.4 moles ($P_{330.9} = 0.953$); between 4.4 and 4.0 moles NH_3 lies a series of solid solutions which show $P = 0.961$ for the following:

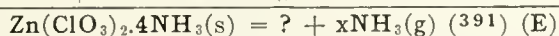
Moles NH_3	4.3	4.1	4.0
<i>T</i> , °K.....	332.1	334.6	336.6



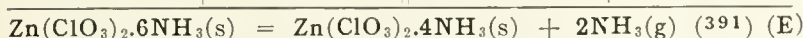
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
194.6	0.0380	213.1	0.1871
203.1	0.0816	218.1	0.2769
208.1	0.1237	223.1	0.3923
$\Delta H = 28\,280$			



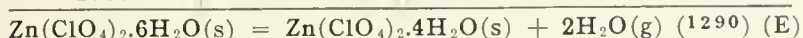
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
310.6	0.082	348.6	0.579
324.6	0.130	360.1	1.000 (extrap.)
338.6	0.342	$\Delta H = 12\,790x$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
387.1	0.021	450.1	0.116
413.1	0.042	489.1	1.000 (extrap.)
438.1	0.066		

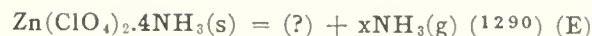


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
258.1	0.296	274.1	0.591
259.1	0.305	276.1	0.639
263.1	0.355	279.1	0.724
265.1	0.400	280.6	0.782
267.1	0.437	283.1	0.908
271.1	0.511	284.1	0.983
273.1	0.562	$\Delta H = 19\,600$	

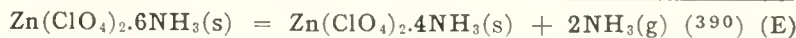


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
373.1*	0.011	503.1	0.036
391.1	0.029	523.1	0.045
398.1	0.029	533.1†	0.064
483.1	0.032		

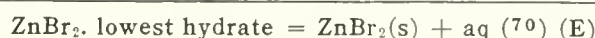
* Transition point at 373.1°K. † Decomposition begins at 533.1°K.



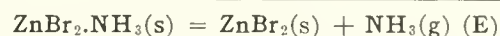
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
343.1	0.009	503.1	0.038
373.1	0.029	523.1	0.042
383.1	0.032	553.1	0.064
408.1	0.032	583.1	0.087
438.1	0.033	598.1	0.136
473.1	0.036		



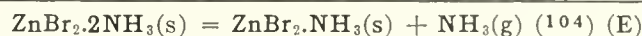
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
265.1	0.063	295.1	0.383
270.6	0.100	301.1	0.507
276.1	0.139	308.1	0.721
283.1	0.204	315.1	1.033
289.1	0.280	$\Delta H = 22\,000$	



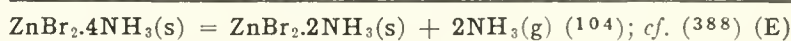
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.00037	323.1	0.00834
298.1	0.00153		



$$P_{678.1} = 0.132 \quad (104, 666); \Delta H = 24\,000 \quad (104)$$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
403.1	0.000021	457.6	0.00305
429.1	0.00083	$\Delta H = 19\,900$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
328.8	0.0095	384.1	0.257
352.7	0.0439	$\Delta H = 27\,100$	

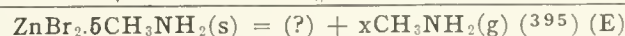


The decomposition exhibits a continuous series of solid solutions, whose dissociation points lie very near one another. The following results are for $P = 0.953$ atm.:

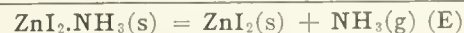
Moles NH_3	<i>T</i>	Moles NH_3	<i>T</i>
6.00	333.6	4.5	341.1
5.60	339.1	4.05	341.6
5.1	340.1	$\Delta H = 22\,040$	

But the pressure is dependent upon the previous history. Fresh $\text{ZnBr}_2 \cdot 6\text{NH}_3$ dissociates at 335.1°K; a day old at 333.6°K (388). Of the three vapor pressure curves of (104, 379, 388), the first two only agree fully and show $P = 1.00$ at 341.6, and $P = 0.132$ at 304.6

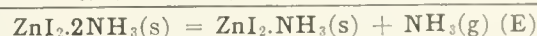
<i>T</i> (388)	<i>P</i>	<i>T</i> (388)	<i>P</i>
285.1	0.039	323.1	0.482
295.1	0.095	326.1	0.568
300.1	0.129	331.1	0.739
307.1	0.196	333.1	0.829
314.1	0.292	336.1	0.957
318.1	0.364	337.1	1.000



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
318.1	0.124	338.1	0.505
330.1	0.318	352.1	1.000 (extrap.)
$\Delta H = 12\,480x \quad (393)$			



$$P_{613.1} = 0.132; \Delta H = 22\,000 \quad (104)$$



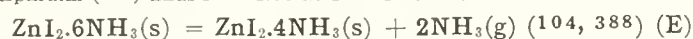
$$P_{429.1} = 0.00139; P_{457.5} = 0.0056; \Delta H = 19\,420 \quad (104)$$



T	P	T	P
329.1	0.00082	429.5	0.1648
353.1	0.00372	457.7	0.5070
383.8	0.018	484.1*	1.000

$$\Delta H = 30\,760$$

* Ephraim (388) finds $P = 1.00$ at $T = 472.1^\circ\text{K}$.

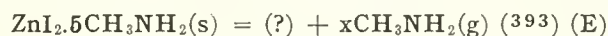


T	P	T	P
273.1*	0.0201	311.1	0.255
284.1	0.049	311.6	0.258
287.1	0.059	317.1	0.362
288.2*	0.054	319.4*	0.3401
290.1	0.071	321.1	0.450
294.1	0.087	322.1	0.468
301.6	0.139	327.3	0.616
302.1*	0.132	331.1	0.741
307.1	0.195	336.1	0.987
307.4*	0.191		$\Delta H^* = 21\,860$

* From (104); all other values from (388).

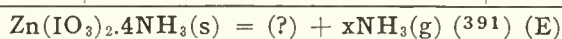
There possibly exist between $\text{ZnI}_2 \cdot 6\text{NH}_3$ and $\text{ZnI}_2 \cdot 5.7\text{NH}_3$ solid solutions, for which Ephraim (388) found $P = 0.961$ as follows:

Moles NH_3	T	Moles NH_3	T
5.92	332.1	5.03	338.1
5.79	336.1	4.08	338.6

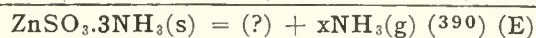


T	P	T	P
314.1	0.258	330.1	0.513
323.1	0.393	344.1	1.000 (extrap.)

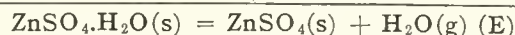
$$\Delta H = 12\,170x$$



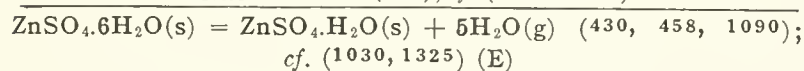
T	P	T	P
350.1	0.058	392.1	0.318
364.6	0.107	403.1	0.468
379.6	0.186	417.1	1.000 (extrap.)



T	P	T	P
325.1	0.078	369.1	0.329
334.1	0.101	379.1	0.658
347.1	0.134	387.1	1.039
360.1	0.204		$\Delta H = 13\,800x$



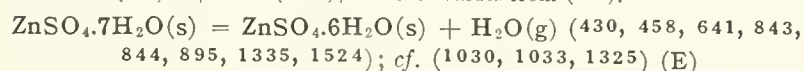
$$P_{298.1} = 0.0013 \quad (430); \text{ cf. } (1030, 1325)$$



$$\Delta H = 11\,400, \text{ calculated from pressures}$$

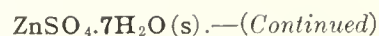
T	P	T	P
290.95	0.0104	298.25	0.01749
293.55	0.01247	302.00	0.02295
298.1*	0.0168	303.05	0.02447
298.1†	0.0171	304.80	0.02773

* From (430). † From (1090); all other values from (458).



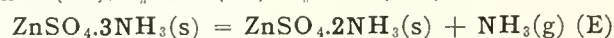
$$\Delta H = 3\,440 \quad (458)$$

T	P	T	P
283.1*	0.0064	293.1§	0.0138
289.6	0.0096	293.55†	0.01326
291.10†	0.01106	295.1	0.0166
293.1*	0.0120	298.1	0.0179

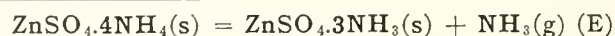


T	P	T	P
298.1¶	0.02018	323.1	0.0962
298.25‡	0.01934	328.1	0.1192
301.45‡	0.02518	333.1	0.1499
303.05‡	0.02814	339.1	0.1914
303.1*	0.0249	343.1	0.2248
307.3†	0.0393	348.1	0.2911
307.6	0.0375	351.9	0.3401
313.1	0.0582	358.6	0.4953
318.1	0.0757	361.1	0.562

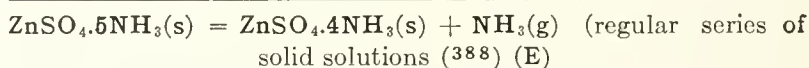
* From (843, 844). † From (895); all other values from (1524). ‡ From (458). § $\pm 0.2^\circ$ from (641). || From (430). ¶ From (1335).



$$P_{458.1} = 0.953 \quad (388)$$

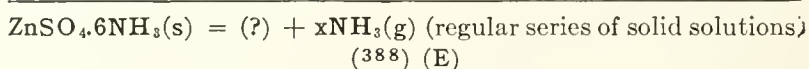


$$P_{371.6} = 0.953 \quad (388)$$



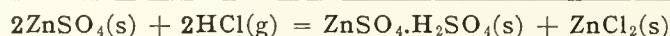
The following results are for $P = 0.953$:

Moles NH_3	T	Moles NH_3	T
5.0	292.1	4.3	314.1
4.5	305.1	4.01	321.1

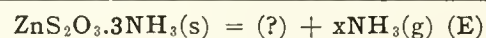


The following results are for $P = 0.953$:

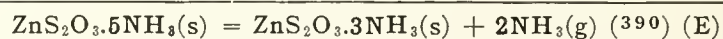
Moles NH_3	T	Moles NH_3	T
6 ca.	238.1	5.3	267.1
5.6	254.1	5.2	274.1



$$P_{273.1} = 0.510; P_{285.4} = 1 \quad (\text{extrap.}) \quad (959)$$

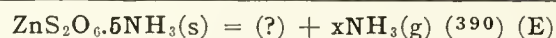


$$P_{423.1} = 0.25 \quad (390)$$



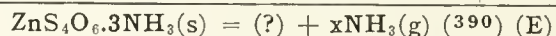
T	P	T	P
288.1	0.037	317.1	0.424
297.1	0.097	327.1	0.834
310.1	0.275	332.1	1.039

$$\Delta H = 23\,400$$

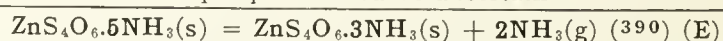


T	P	T	P
First form			
297.1	0.036	333.1	0.507
313.1	0.101	340.1	0.829
327.1	0.322		
Second form			
320.1	0.246	342.1	0.941
333.1	0.550	343.1	1.000 (extrap.)

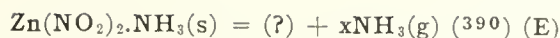
$$\Delta H = 12\,100x$$



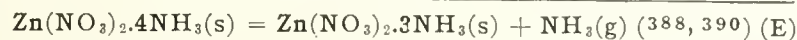
Vapor pressure curve uncertain



T	P	T	P
275.1	0.028	310.1	0.259
284.1	0.047	315.1	0.424
293.1	0.072	318.1	0.458
298.1	0.117	323.1	0.708
301.1	0.142	332.1	1.049
306.1	0.195		$\Delta H = 23\,400$

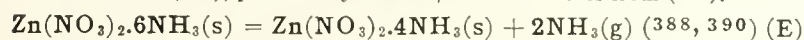


T	P	T	P
298.1	0.033	346.1	0.176
318.1	0.072	353.1	0.208
328.1	0.104	359.1	0.238
337.1	0.136	$\Delta H = 14\ 600x$	



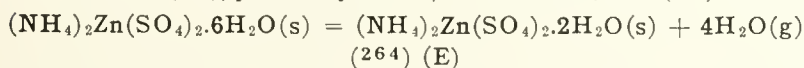
T	P	T	P
380.1	0.024	446.1	0.234
393.1	0.037	456.1	0.358
407.1	0.051	463.1	0.479
418.1	0.074	474.1	0.747
427.1	0.105	479.1*	0.953
434.1	0.142	481.1	1.000
440.1	0.182	$\Delta H = 17\ 600$	

* Value from (388), particularly reliable; all other values from (390).



T	P	T	P
273.1	0.209	298.1	0.699
279.1	0.284	303.1	0.876
283.1	0.349	303.6*	0.953
288.1	0.442	306.1	0.995
293.1	0.557	$\Delta H = 21\ 400$	

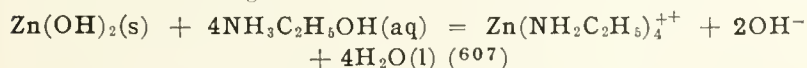
* Value from (388), particularly reliable; all other values from (390).



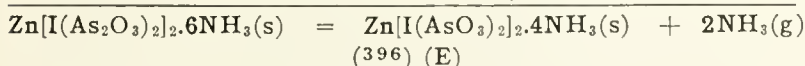
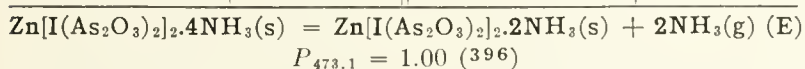
$$\log P = 2.755 + 471.5/T - 622\ 000/T^2$$

T	P	T	P
303.8	0.0037*	332.8	0.0361
315.6	0.0097	337.8	0.0497*
318.1	0.0122*	341.1	0.0616*
320.7	0.0143	343.3	0.0708
328.7	0.0270	352.5	0.1219
329.6	0.0287*	$\Delta H = 61\ 600$	

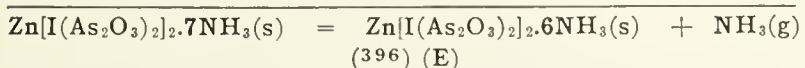
* Measured on cooling.



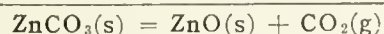
$c(\text{NH}_3\text{C}_2\text{H}_5\text{OH})$ total	$c(\text{Zn})$	$c(\text{NH}_3\text{C}_2\text{H}_5\text{OH})$ total	$c(\text{Zn})$
0.068	0.00015	0.68	0.0049
.51	.00225		



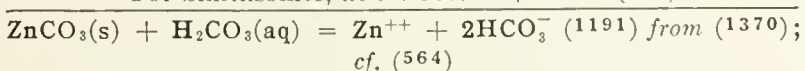
Decomposition between 343.1 and 360.1°K gives a series of solid solutions



Decomposition begins at 253.1°K, and leads through a series of solid solutions, to the hexammine at 343.1°K



For Smithsonite, at ca. 668.1°K, $P = 1$ (453)



$$\log p.f._{298.1} = 2.292; \Delta H = -7\ 150; \Delta F_{298.1}^0 = 9\ 385$$

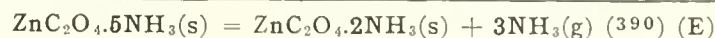
$c(\text{H}_2\text{CO}_3)$	$c(\text{Zn}^{++})$	$c(\text{HCO}_3^-)$	$\mu_c^{1/2}$	$\log (1/K^{1/2})$
$T = 298.1^\circ\text{K}$				
0.1390	0.00194	0.00388	0.076	2.2258
.1797	.00211	.00422	.080	2.2263
.2579	.00242	.00484	.085	2.2194



$c(\text{H}_2\text{CO}_3)$	$c(\text{Zn}^{++})$	$c(\text{HCO}_3^-)$	$\mu_c^{1/2}$	$\log (1/K^{1/2})$
$T = 298.1^\circ\text{K}. - (\text{Continued})$				
0.3580	0.00270	0.00540	0.090	2.2192
.4103	.00278	.00556	.091	2.2263
.4480	.00291	.00582	.093	2.2192
.6657	.00317	.00634	.098	2.2395
.6969	.00319	.00638	.098	2.2432
.7610	.00343	.00686	.101	2.2245
1.3701	.00445	.00890	.115	2.1965

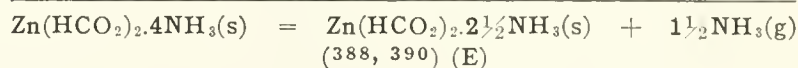
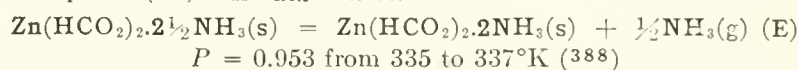
$T = 303.1^\circ\text{K}$

$c(\text{H}_2\text{CO}_3)$	$c(\text{Zn}^{++})$	$c(\text{HCO}_3^-)$	$\mu_c^{1/2}$	$\log (1/K^{1/2})$
0.1838	0.00215	0.00430	0.080	2.2216
.3838	.00277	.00554	.091	2.2181
.4038	.00286	.00572	.093	2.2117
.4601	.00308	.00616	.096	2.1981
.6064	.00324	.00648	.099	2.2163
.6257	.00337	.00674	.100	2.2037
.7470	.00352	.00704	.102	2.2105
.8351	.00376	.00752	.106	2.1979
1.0840	.00339	.00678	.101	2.2809
1.1275	.00429	.00858	.114	2.1840

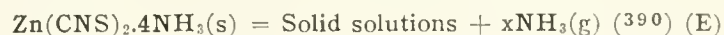


T	P	T	P
256.1	0.053	280.1	0.441
260.1	0.083	283.1	0.524
265.1	0.139	288.1	0.705
267.1	0.171	291.1*	0.841*
270.1	0.229	294.1	0.978
275.1	0.326	295.1	1.026
$\Delta H = 30\ 600$			

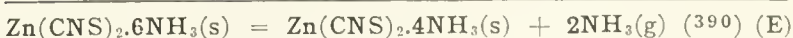
* Ephraim (388) finds $P_{291.1} = 0.953$.



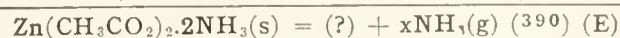
T	P	T	P
281.1	0.078	309.1	0.451
287.1	0.118	315.1	0.625
292.1	0.164	319.1	0.766
296.1	0.211	324.1	0.980
301.1	0.283	$\Delta H = 17\ 100$	



T	P	T	P
304.1	0.026	350.1	0.397
318.1	0.058	353.1	0.511
330.1	0.111	358.1	0.776
337.1	0.166	361.1	1.013
345.1	0.266	$\Delta H = 12\ 800x$	



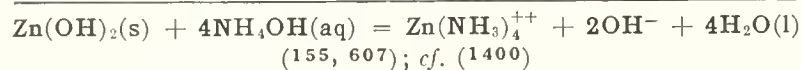
T	P	T	P
252.1	0.329	273.1	0.945
258.1	0.441	274.1	1.000 (extrap.)
$\Delta H = 19\ 000$			



T	P	T	P
377.1	0.043	395.1	0.129
387.1	0.075	403.1	0.236
391.1	0.097	411.1	0.451

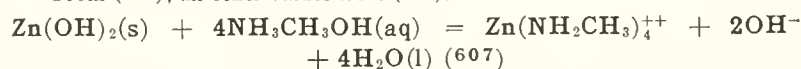
Zn(CH₃CO₂)₂·2NH₃(s).—(Continued)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
409.1	0.368	420.1	0.930
418.1	0.783	421.1	1.037
$\Delta H = 15\ 200\text{x}$			

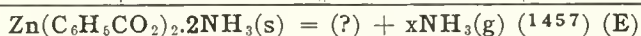


<i>c</i> (NH ₄ OH) total	<i>c</i> (Zn)	<i>c</i> (NH ₄ OH) total	<i>c</i> (Zn)
0.0942*	0.00055	1.215	0.0332
.236*	.0055	1.928	.0623
.321	.00417	2.570	.0862
.643	.01038	3.213	.1249
.707*	.0295		

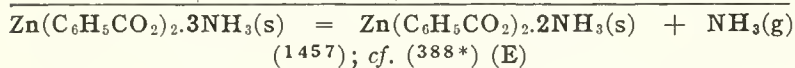
* From (607); all other values from (155).



<i>c</i> (NH ₃ CH ₃ OH) total	<i>c</i> (Zn)	<i>c</i> (NH ₃ CH ₃ OH) total	<i>c</i> (Zn)
0.0944	0.00025	0.944	0.015
.472	.00405		

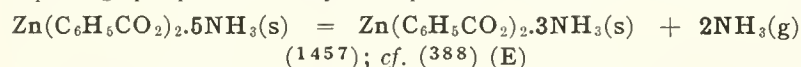


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
408.1	0.141	455.1	0.704
426.1	0.218	461.1	0.939
442.1	0.388	463.1	1.000

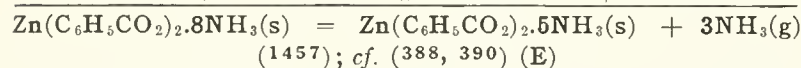


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
299.1	0.121	323.1	0.632
308.1	0.230	328.1	0.875
318.1	0.454	330.1	1.000

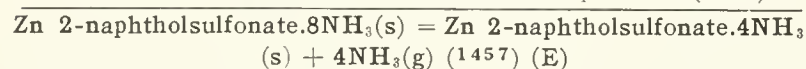
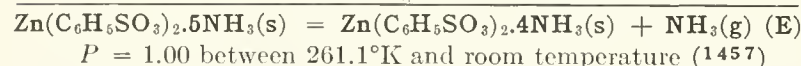
* According to Ephraim (388), *P* = 0.953 at *T* between 329.1 and 338.6°K, depending upon previous history of sample.



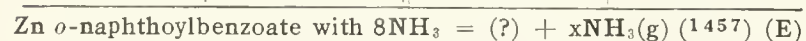
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
278.1	0.461	288.1	0.724
283.1	0.533	291.1	0.980
285.6	0.605	294.1	0.953



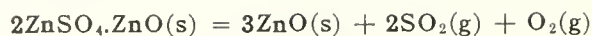
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
254.1	0.346	266.1	0.770
258.1	0.408	270.6	1.000
260.1	0.528	271.1	1.058
263.1	0.632	$\Delta H = 27\ 900$	



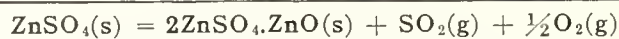
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
254.1	0.272	269.1	0.592
258.1	0.336	273.1	0.842
265.6	0.474	274.6	1.000



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
255.1	0.368	265.1	0.789
259.1	0.513	267.1	1.000
260.6	0.566		

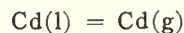
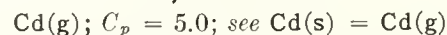


$$P_{1203.1} = 1.00 \quad (455)$$



$$P_{1113.1} = 1.00 \quad (455); \text{cf. (636, 835)}$$

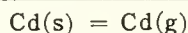
Cd, Cadmium



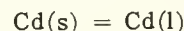
$$\Delta F^0 = 26\ 645 + 2.50T \ln T - 43.068T; \Delta F_{298.1}^0 = 18\ 053 \quad (936) \\ \text{from (166, 427, 616, 617)}$$



$$\Delta F^0, \Delta H^0 = 0; C_p = 5.46 + 0.0026T \quad (936) \text{ from (515, 1043)}$$



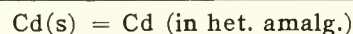
$$\Delta F^0 = 27\ 050 + 0.46T \ln T + 0.0013T^2 - 31.301T; \Delta F_{298.1}^0 = 18\ 616 \quad (936) \text{ from (368)}$$



$$\Delta F^0 = 405 - 2.04T \ln T + 0.0013T^3 + 11.767; \Delta F_{298.1}^0 = 563 \quad (936); \text{cf. (1131, 1232, 1242)}$$

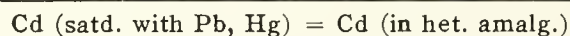
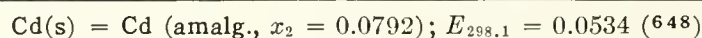


$$E_{298.1}^0 = 0.3976; \Delta F_{298.1}^0 = -18\ 348 \quad (885) \text{ from (648)}$$

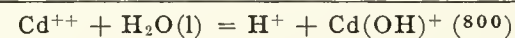
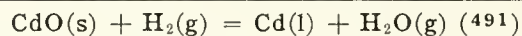


$$E = A - Bt$$

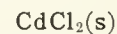
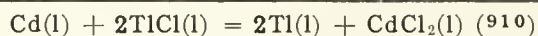
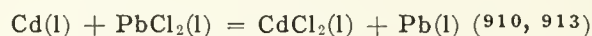
10 ⁴ A	10 ⁴ B	<i>E</i> _{298.1}	% Amalg.	Range, °C	Lit.
566.3	2.44	0.05053	12.5	12.1–60	(661)
565.6	2.437	0.05047	10	0–51	(662)
563.9	2.42	0.05034	10	CdSO ₄ (aq)	(1093)
563.7	2.48	0.05021	10	CdCl ₂ (aq)	(1093)
562.7	2.48	0.05008	10	CdBr ₂ (aq)	(1093)
565.8	2.48	0.05040	10	CdI ₂ (aq)	(1093)



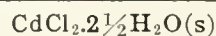
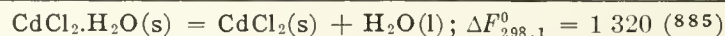
$$E = 0.00113 + 0.000025(t - 25) + 0.0000002(t - 25)^2; E_{273.1} = 0.000630; E_{298.1} = 0.00113 \quad (1480)$$



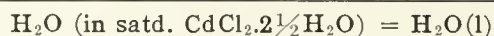
<i>c</i> (CdCl ₂)	% hydrolysis, 373.1°K
0.0156	0.0072
0.0625	0.0045



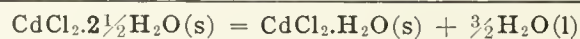
$$\Delta F_{298.1}^0 = -82\ 260; E_{568.1}^0 = 1.54; \Delta F_{568.1}^0 = -72\ 320 \quad (885) \text{ from (1509)}$$



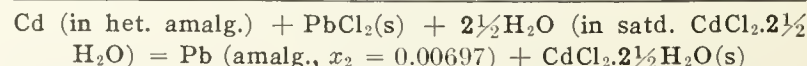
$$E_{298.1}^0 = 1.8236; \Delta F_{298.1}^0 = -84\ 156 \pm 150 \quad (1189) \text{ from (648, 901, 1093, 1099, 1429, 1482)}$$



$$\Delta F_{298.1}^0 = 220 \quad (885) \text{ from (847, 1419, 1420)}$$



$$\Delta F_{307.2}^0 = 360; \Delta F_{298.1}^0 = 430 \quad (885)$$



$$E_{273.1} = 0.1484; E_{298.1} = 0.1484 \quad (1429)$$

$\text{Cd (in het. amalg.)} + \text{PbCl}_2(\text{s}) + 2\frac{1}{2} \text{H}_2\text{O (in satd. CdCl}_2\cdot 2\frac{1}{2} \text{H}_2\text{O}) = \text{Pb (in het. amalg.)} + \text{CdCl}_2\cdot 2\frac{1}{2} \text{H}_2\text{O(s)}$
 $E = 0.14178 - 0.000200(t - 20) - 0.000002(t - 20)^2$; $E_{298.1} = 0.14073$; $E_{273.1} = 0.1450$ (1093); $E = 0.13759 - 0.000193(t - 25) - 0.0000012(t - 25)^2$; $E_{298.1} = 0.13759$; $E_{273.1} = 0.14157$ (1482)

$\text{Cd (satd. with Pb, Hg)} + \text{PbCl}_2(\text{s}) + 2\frac{1}{2} \text{H}_2\text{O (in satd. CdCl}_2\cdot 2\frac{1}{2} \text{H}_2\text{O}) = \text{Pb (in het. amalg.)} + \text{CdCl}_2\cdot 2\frac{1}{2} \text{H}_2\text{O(s)}$
 $E^0 = 0.13872 - 0.000168(t - 25) - 0.0000010(t - 25)^2$; $E_{298.1}^0 = 0.13872$; $E_{273.1}^0 = 0.14286$ (1482)

CdCl_2 (1, 2, and 4NH_3) (801) (E)

$\text{CdCl}_2\cdot 6\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (379); cf. (801, 819) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
286.6	0.068	321.6	0.596
298.1	0.142	325.1	0.697
304.1	0.224	326.6	0.758
310.6	0.326	329.1	0.836
315.1	0.432	331.1	0.934
318.1	0.500	332.6	1.007

$\Delta H = 11\ 400\text{x}$

$\text{Cd(ClO}_3)_2\cdot 4\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (391) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
389.6	0.154	409.1	0.441
398.6	0.229	426.1	1.00 (interp.)

$\Delta H = 15\ 400\text{x}$

$\text{Cd(ClO}_3)_2\cdot 6\text{NH}_3(\text{s}) = \text{Cd(ClO}_3)_2\cdot 4\text{NH}_3(\text{s}) + 2\text{NH}_3(\text{g})$ (391) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
342.1	0.117	376.6	0.434
355.1	0.205	389.6	0.697
367.1	0.317	395.1	1.015

$\Delta H = 28\ 200$

$\text{Cd(ClO}_4)_2\cdot 6\text{H}_2\text{O(s)} = \text{Cd(ClO}_4)_2\cdot 4\text{H}_2\text{O(s)} + 2\text{H}_2\text{O(g)}$ (1290) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
368.1	0.013	563.1	0.172
383.1	0.039	598.1	0.233

$\text{Cd(ClO}_4)_2\cdot 6\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (1290) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
343.1	0.033	503.1	0.083
393.1	0.043	523.1	0.097
423.1	0.045	543.1	0.170
453.1	0.068	563.1	0.242
473.1	0.080		

$\text{CdBr}_2\cdot 4\text{H}_2\text{O(s)}$

$E_{298.1}^0 = 1.5617$; $\Delta F_{298.1}^0 = -72\ 070$ (1189) from (1093, 1099)

$\text{H}_2\text{O (in satd. CdBr}_2\cdot 4\text{H}_2\text{O}) = \text{H}_2\text{O(l)}$

$\Delta F_{298.1}^0 = 337$ (1189) from (847)

$\text{Cd (in het. amalg.)} + \text{PbBr}_2(\text{s}) + 4\text{H}_2\text{O (in satd. CdBr}_2\cdot 4\text{H}_2\text{O}) = \text{Pb (in het. amalg.)} + \text{CdBr}_2\cdot 4\text{H}_2\text{O(s)}$
 $E = 0.14505 - 0.00037(t - 20) - 0.00005(t - 20)^2$; $E_{298.1} = 0.14330$; $E_{273.1} = 0.15045$ (1093)

$\text{CdBr}_2\cdot 4\text{H}_2\text{O(s)} = \text{CdBr}_2(\text{s}) + 4\text{H}_2\text{O(g)}$ (847) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.0118	333.1	0.163

The vapor pressure is not distinguishable from that of the saturated solution.

$\text{CdBr}_2\cdot 6\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (379) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
304.1	0.051	340.1	0.453
318.1	0.136	344.1	0.559
323.1	0.182	349.1	0.704
329.1	0.253	355.4	0.921
333.6	0.324	357.4	1.026

$\Delta H = 12\ 700\text{x}$

$\text{CdBr}_2\cdot 3\text{NH}_2\text{CH}_3(\text{s}) = (?) + x\text{NH}_2\text{CH}_3(\text{g})$ (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
316.1	0.179	349.1	1.000 (interp.)
328.1	0.353	350.6	1.072
342.6	0.743	356.1	1.283

$\Delta H = 13\ 610\text{x}$

$\text{CdI}_2(\text{s})$

$E_{298.1}^0 = 1.0438$; $\Delta F_{298.1}^0 = -48\ 169 \pm 10$ (?) (1189) from (1093, 1099, 1429, 1482, 1559)

$\text{Cd (in het. amalg.)} + \text{PbI}_2(\text{s}) = \text{Pb (amalg., } x_2 = 0.000697) + \text{CdI}_2(\text{s})$

$E_{273.1} = 0.09655$; $E_{298.1} = 0.10725$; $E_{313.1} = 0.1350$ (1429)

$\text{Cd (in het. amalg.)} + \text{PbI}_2(\text{s}) = \text{Pb (in het. amalg.)} + \text{CdI}_2(\text{s})$
 $E = 0.09839 + 0.000245(t - 20) - 0.000001(t - 20)^2$;
 $E_{298.1} = 0.09958$; $E_{273.1} = 0.09309$ (1093); $E = 0.0997 + 0.000235(t - 25) - 0.0000002(t - 25)^2$; $E_{298.1} = 0.0997$ (1482)

$\text{Cd (amalg. satd. Pb, Hg)} + \text{PbI}_2(\text{s}) = \text{Pb (in het. amalg.)} + \text{CdI}_2(\text{s})$

$E = 0.1007 + 0.000026(t - 25)$; $E_{298.1} = 0.1007$; $E_{273.1} = 0.0942$ (1482)

$\text{CdI}_2\cdot 6\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (379) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
291.1	0.004	364.1	0.487
297.1	0.011	367.6	0.572
317.1	0.039	372.1	0.691
332.1	0.078	372.6	0.713
337.6	0.126	376.6	0.833
342.6	0.166	377.6	0.876
351.6	0.268	380.6	0.964
358.1	0.357		

$\Delta H = 13\ 600\text{x}$

$\text{CdI}_2\cdot 3\text{NH}_2\text{CH}_3(\text{s}) = (?) + x\text{NH}_2\text{CH}_3(\text{g})$ (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
316.6	0.063	356.6	0.434
327.6	0.125	371.6	0.743
340.1	0.224	381.6	1.007

$\Delta H = 13\ 610\text{x}$

$\text{Cd(IO}_3)_2\cdot 4\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (391) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
364.1	0.501	383.1	0.933
374.1	0.639		

Previous treatment with NH_3 in the cold:

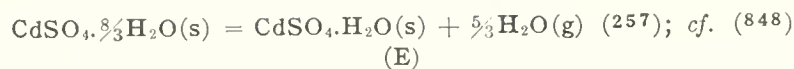
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
296.6	0.074	327.1	0.266
304.1	0.125	338.1	0.292
314.6	0.222		

$\Delta H = 13\ 700\text{x}$

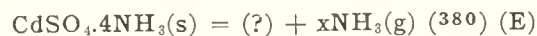
$\text{CdSO}_4(\text{s}) = (?) + \text{SO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$ (636)

$\text{CdSO}_4\cdot \text{H}_2\text{O(s)} = \text{CdSO}_4(\text{s}) + \text{H}_2\text{O(g)}$ (848) (E)

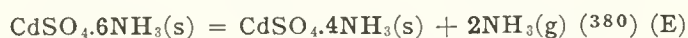
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
438.1	0.072	447.6	0.213
443.1	0.151		



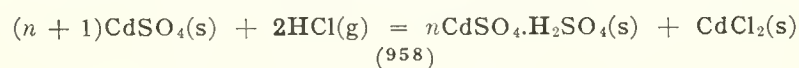
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
298.1	0.0234	308.28	0.0461
303.28	0.0336	313.35	0.0641



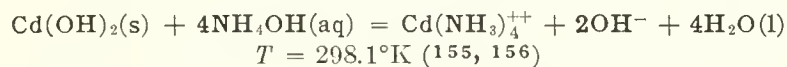
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
325.6	0.151	352.1	0.691
334.1	0.263	355.6	0.796
338.1	0.322	356.1	0.836
344.6	0.447	359.6	0.974
346.1	0.507	$\Delta H = 12 \ 830\text{x}$	



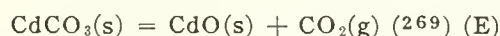
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
291.1	0.074	325.1	0.720
306.1	0.205	331.6	0.980
315.1	0.391	$\Delta H = 23 \ 660$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
338.7	0.0863	380.8	0.735
353.3	.208	390.1	.917
373.1	.509	394.1	1.000



<i>c</i> (NH ₄ OH) total	<i>c</i> (Cd)	<i>c</i> (NH ₄ OH) total	<i>c</i> (Cd)
0.5	0.00187	1.8	0.01037
1.0	0.00483	4.6	0.03735

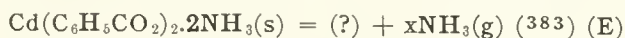


$$\log P = -43 \ 630/4.6T + 15.113 \quad (269); \log P = -4 \ 703.1/T + 1.75 \log T - 0.0007514T + 3.2 \quad (20); \text{ cf. } (272, 273, 970)$$

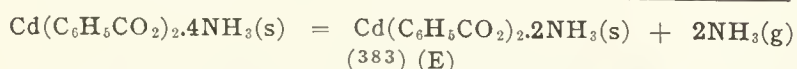
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
523.1	0.00066	613.1	0.434*
535.1	0.0033	615.1	0.403
553.1	0.0053	620.1	0.536
573.1	0.0079	623.1	0.750*
581.1	0.030	626.1	0.691
588.1	0.072	632.1	1.042
593.1	0.132*	633.1	1.349*
595.1	0.1324	636.1	1.574
603.1	0.250	641.1	2.062

$$\Delta H = 21 \ 860$$

* Interpolated according to equation: $\log P = -15.32 + 0.02439 \ T$.

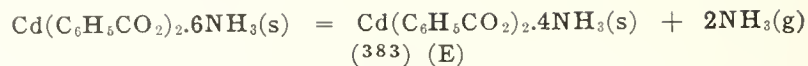


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
431.1	0.336	453.1	0.921
441.1	0.572	455.1	0.993
447.1	0.724		

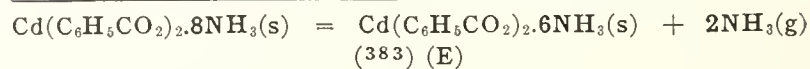


In the decomposition, solid solution results

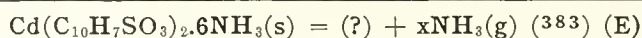
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
296.1	0.317	313.1	0.875
301.1	0.439	315.1	1.000
306.1	0.579		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.316	287.1	0.789
278.1	0.447	290.1	0.953
280.1	0.511	290.6	1.000
283.1	0.618		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
Fresh substance			
258.1	0.468	278.1	0.941
263.1	0.511	279.1	1.000
273.1	0.730		
Old substance			
254.1	0.330	267.1	0.632
263.1	0.483	273.1	0.901
265.1	0.559	274.6	1.000



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
325.1	0.224	359.1	0.822
334.1	0.329	362.1	0.925
346.1	0.528	363.6	1.000
351.1	0.651		

Hg, Mercury

Hg(g)

$$C_p = 5.0; \Delta H_{298.1}^0 = 14 \ 690; \Delta F_{298.1}^0 = 7 \ 632; \Delta S_{298.1}^0 = 23.679; \Delta F^0 = 15 \ 391 + 3.42T \ln T - 0.0049T^2 + 0.0000022T^3 - 14.252T \quad (\text{valid below } 140^\circ\text{C}) \quad (1183)$$

Hg(l)

$$\Delta H^0, \Delta F^0 = 0; C_p (-40 \text{ to } +140^\circ\text{C}) = 8.42 - 0.0098T + 0.0000132T^2; S_{298.1}^0 = 17.831 \quad (1183)$$

Hg(l'), hypothetical liquid mercury

$$C_p = 6.73 - 0.001T + 0.00000156T^2 \quad (1183)$$

Hg(l) = Hg(l') (1183)

<i>T</i> , °K	<i>C_p</i> , Hg(l)	<i>C_p</i> , Hg(l')	ΔC_p	ΔS	ΔH	$T\Delta S$	ΔF
233.1	6.965	6.582	-0.383	0.06633	18.223	15.46	2.76
253.1	6.797	6.577	-0.220	.04161	12.443	10.53	1.91
273.1	6.730	6.573	-0.157	.02728	8.673	7.45	1.22
293.1	6.684	6.571	-0.113	.01769	5.973	5.18	0.79
298.1	6.676	6.570	-0.106	.01583	5.425	4.72	.71
313.1	6.650	6.570	-0.080	.01127	4.03	3.53	.50
333.1	6.626	6.570	-0.056	.00705	2.67	2.35	.32
353.1	6.610	6.572	-0.038	.00432	1.73	1.53	.20
373.1	6.599	6.574	-0.025	.00256	1.10	0.96	.14
393.1	6.593	6.578	-0.015	.00152	0.70	.60	.10
413.1	6.592	6.583	-0.009	.00093	.46	.38	.08
433.1	6.595	6.590	-0.005	.00063	.32	.27	.05
453.1	6.600	6.597	-0.003	.00045	.24	.20	.04

Hg(l') = Hg(g)

$$\Delta F^0 = 15 \ 170 + 1.73T \ln T - 0.0005T^2 + 0.00000026T^3 - 35.020T \quad (\text{range } 235.1 \text{ to } 1708.1^\circ\text{K}); \Delta H_{298.1}^0 = 14 \ 685; \Delta S_{298.1}^0 = 23.663; \Delta F_{298.1}^0 = 7 \ 631 \quad (1183) \text{ from } (85, 234, 368, 549, 770, 771, 984, 985, 1149, 1168.5, 1234, 1378, 1379, 1380); \text{ cf. } (427)$$

Hg(s)

$$C_p (\text{above } 100^\circ\text{K}) = 5.31 + 0.00614T \quad (1183); \text{ see } \text{Hg(l)} = \text{Hg(s)}$$

Hg(s) = Hg(g)

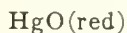
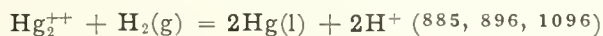
$$\Delta F^0 = 15 \ 595 + 0.31T \ln T - 0.00307T^2 - 29.90T \quad (1183)$$



$\Delta F_{234.23}^0 = 0$ (1183) from (604, 1527, 1528); $\Delta H_{298.1}^0 = -551.7$ (1151); $\Delta F^0 = -204 + 3.11T \ln T - 0.00797T^2 + 0.0000022T^3 - 14.352T$; $\Delta H_{298.1}^0 = -539.4$; $\Delta F_{298.1}^0 = 149.3$ (1183)



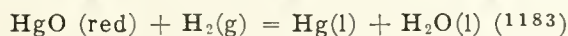
$E_{298.1}^0 = -0.7986$; $\Delta F_{298.1}^0 = 36\ 854$ (885)



$C_p = 9.00 + 0.006T$ (885); $\Delta H = -21\ 500$ (1468) = $-21\ 700$ (190, 191); $\Delta H_{298.1}^0 = -21\ 600$ (1183, 1185); $\Delta F_{298.1}^0 = -13\ 808$ (885); = $-13\ 950$ (1183) from (1427); = $-14\ 063$ (1183) from third law of thermodynamics

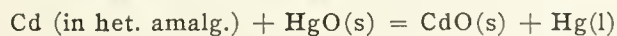
$\text{HgO (red)} = \text{Hg(g)} + \frac{1}{2}\text{O}_2(\text{g})$ (1183) from (1427); cf. (1123)
 $\Delta F^0 = 36\ 728 + 0.75T \ln T + 0.00275T^2 - 56.000T$; $\Delta H_{298.1}^0 = 36\ 290$; $\Delta F_{298.1}^0 = 21\ 582$

$T, ^\circ\text{K}$	Total P in atm.	$-R \ln K$	I
633.1	0.1185	8.262	-56.377
643.1	.1422	7.719	-56.058
653.1	.1858	6.923	-56.016
663.1	.2370	6.195	-55.936
673.1	.3040	5.451	-55.872
683.1	.3990	4.642	-55.943
693.1	.5095	3.911	-55.935
703.1	.6550	3.159	-55.972
713.1	.8450	2.402	-56.033
723.1	1.067	1.709	-56.052
733.1	1.339	1.030	-56.074
743.1	1.679	0.3554	-56.113
753.1	2.081	.2862	-56.562

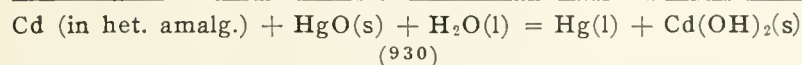


$E_{298.1}^0 = 0.9264$; $\Delta F_{298.1}^0 = -42\ 752$

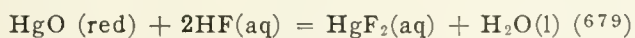
Hydroxide	m	$E_{298.1}^0$	Lit.
NaOH	0.672	0.9263	(190, 191)
	4.80	.9293	
	10.00	.9355	
	0.316	.92640	(279)
	.101	.92637	
	.0316	.92644	
	.0103	.92608	
	.00310	.92637	
KOH	.00105	.92666	
	.09635	.92646	(218)



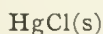
$E_{298.1} = 0.824$; $\Delta F_{298.1} = -38\ 040$ (930)



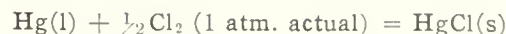
In NaOH, m	$E_{298.1}^0$	$\Delta F_{298.1}^0$
1.0	0.8595	-39 667
13.0	0.85014	-39 232



$C(\text{HF})$	$C(\text{HgF}_2)$	$C(\text{HF})$	$C(\text{HgF}_2)$
0.12	0.01258	1.11	0.1168
.24	.0247	2.17	.2586
.57	.0629		



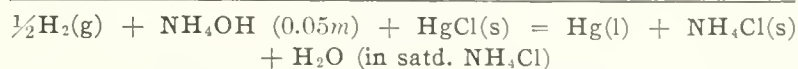
$E_{298.1}^0 = 1.0905$; $\Delta F_{298.1}^0 = -25\ 163 \pm 5$ (1189) from (470); cf. (193, 1195, 1548)



$E = 1.1040 - 0.000945t$; $E_{298.1} = 1.0904$ (1189) from (470); $E = 1.1090 - 0.00100t$; $E_{298.1} = 1.0843$ (1189) from (1548)



$E_{298.1}^0 = 0.2700$; $\Delta F_{298.1}^0 = -6\ 230$ (885); revised value, $E_{298.1}^0 = 0.2676$; $\Delta F_{298.1}^0 = -6\ 175$ (1195); cf. (261, 372, 576, 578, 579, 864, 897, 898, 907, 909, 1172, 1443)



$E_{298.1} = 0.6924$; $\Delta F_{298.1} = -15\ 980$ (193); $\Delta H = -70\ 600$; $\Delta F_{298.1}^0 = -14\ 670$ (1189)

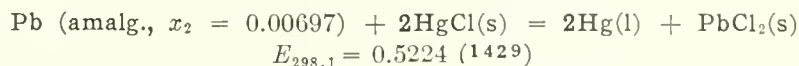


$E = A + Bt$

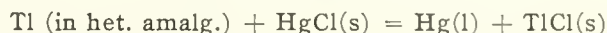
A	B	$E_{298.1}$	Lit.
0.5321	0.000147	0.5358	(470)
0.5277	0.000210	0.5329	(530)
0.5274	0.00020	0.5324	(792)



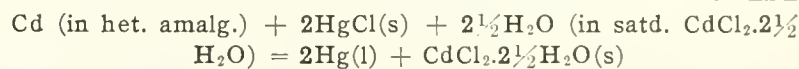
$E = 0.5265 + 0.00013t$; $E_{298.1} = 0.5298$ (37); $E = 0.52657 + 0.000133t$; $E_{298.1} = 0.5299$ (470)



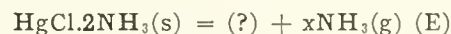
$E_{298.1} = 0.5224$ (1429)



$E_{298.1} = 0.8225$; also Tl (in het. amalg.), TlCl(s), 0.1 KCl, N-electrode, $E_{298.1} = 0.7704$ (891)



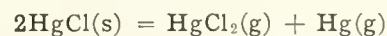
$E = 0.67080 - 0.000102(t - 25) - 0.0000025(t - 25)^2$; $E_{298.1} = 0.67080$; $E_{273.1} = 0.67329$ (901); $E = 0.67179 - 0.000074(t - 18) - 0.0000015(t - 18)^2$; $E_{298.1} = 0.67118$; $E_{273.1} = 0.67254$ (1099)



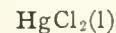
$P_{631.1} = 0.887$; $P_{640.1} = 1.202$ (666); $\Delta H = 14\ 330x$ (153)



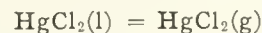
$\Delta H_{298.1}^0 = -36\ 658$; $\Delta F_{298.1}^0 = -34\ 569$ (1183)



$\Delta F^0 = 41\ 350 - 60.271T$ (range 363 to 676°K); $\Delta H_{298.1}^0 = 41\ 350$; $\Delta F_{298.1}^0 = 23\ 383$; $\Delta C_p = 0$ (1183) from (404, 1198, 1372, 1380, 1525)



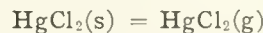
$\Delta H_{298.1}^0 = -51\ 938$; $\Delta F_{298.1}^0 = -41\ 932$ (1183)



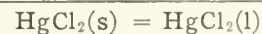
$\Delta F^0 = 15\ 280 - 26.557T$ (range 551 to 575°K); $\Delta F_{298.1}^0 = 7\ 363$ (1183) from (713)



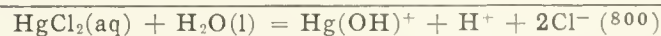
$\Delta H_{298.1}^0 = -55\ 428$; $\Delta F_{298.1}^0 = -43\ 550$ (1183)



$\Delta F^0 = 18\ 770 - 32.837T$ (range 363 to 548°K); $\Delta H_{298.1}^0 = 18\ 770$; $\Delta F_{298.1}^0 = 8\ 981$ (1183) from (713, 1525)



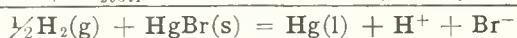
$\Delta F^0 = 3\ 490 - 6.280T$; $\Delta F_{555.7}^0 = 0$ (1183); cf. (713, 733); $\Delta F_{513.1}^0 = 0$ (1293); $\Delta F_{550.5}^0 = 0$ (1105)



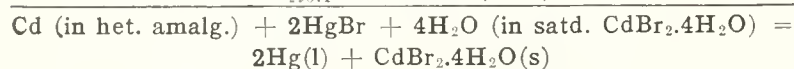
$C(\text{HgCl}_2)$	% Hydrolysis at 358.6°K	% Hydrolysis at 373.6°K
0.000977	4.87	6.91
.00392	2.31	2.99
.0157	1.06	1.35
.0625	0.451	0.60

HgBr(s)

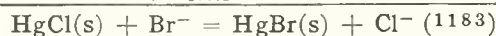
$$E_{298.1}^0 = 0.9253; \Delta F_{298.1}^0 = -21\,351 \pm 10 \text{ (1189) from (472, 1183)}$$



$$E_{298.1} (m = 0.10015) = 0.2685 \text{ (472); } E_{298.1}^0 = -0.1397; \Delta F_{298.1}^0 = -3\,223 \text{ (1189)}$$



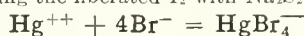
$$E = 0.55916 - 0.000366(t - 18) - 0.0000046(t - 18)^2; E_{298.1}^0 = 0.55638; E_{273.1}^0 = 0.56426 \text{ (1099)}$$



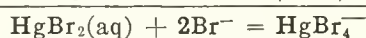
$$E_{298.1}^0 = 0.1274; \Delta F_{298.1}^0 = -2\,940 \pm 10$$

$m(\text{H}^+)$	$m(\text{Cl}^-)$	$m(\text{Br}^-)$	K_m
0.00909	0.00907	0.000084	108.5
.00781	.00747	.00013	57.5
.04429	.04390	.00019	231.1
.04005	.03988	.00011	362.5
.09994	.09631	.00317	30.4
.1092	.0824	.00087	94.7
.2021	.2012	.00190*	105.9

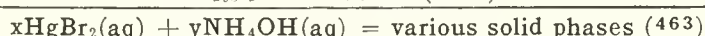
* Estimated by titrating the liberated I_2 with $\text{Na}_2\text{S}_2\text{O}_3$ solution.



$$K_{298.1} = 4.3 \times 10^{21} \text{ (1343)}$$

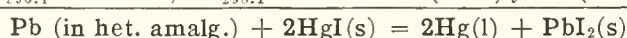


$$K_{298.1} = 2.8 \times 10^4 \text{ (1343)}$$

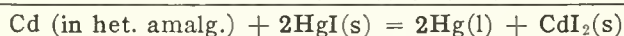


HgI(s)

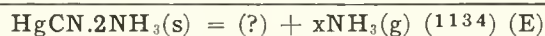
$$E_{298.1}^0 = 0.5761; \Delta F_{298.1}^0 = -13\,290 \text{ (1189) from (1481)}$$



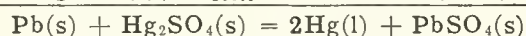
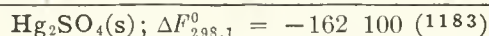
$$E_{298.1} = 0.3175 \text{ (1481); cf. (471)}$$



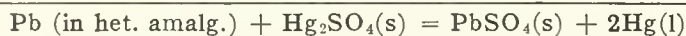
$$E = 0.41470 + 0.000362(t - 18) - 0.0000003(t - 18)^2; E_{298.1}^0 = 0.41722; E_{273.1}^0 = 0.40809 \text{ (1099); } E = 0.41885 + 0.0003568(t - 30) + 0.0000008(t - 30)^2; E_{298.1}^0 = 0.41709; E_{273.1}^0 = 0.41065 \text{ (1559)}$$



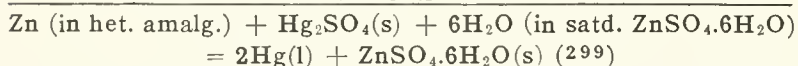
T	P	T	P
278.1	0.004	303.1	0.0243
283.1	0.005	308.1	0.033
288.1	0.008	313.1	0.0454
292.1	0.008	318.1	0.059
293.1	0.0112	323.1	0.075
296.1	0.0112	328.1	0.096
298.1	0.0204	332.1	0.114



$$E_{298.1}^0 = 0.9697 \text{ (598); cf. (420)}$$

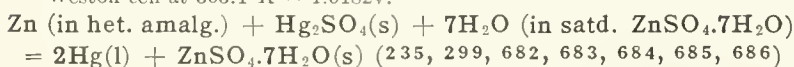


$$E_{298.1} = 0.96466; \Delta F_{298.1}^0 = -44\,516 \text{ (979)}$$



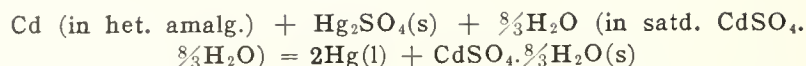
T	E^*	T	E^*
298.1	1.41371	318.1	1.39400
303.1	1.40952	323.1	1.38823
308.1	1.40462	328.1	1.38212
311.1	1.40143		

* Weston cell at 303.1°K = 1.0182v.

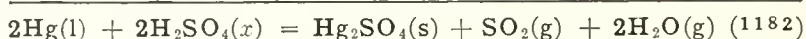


T	E^*	T	E^*
298.1	1.41974	308.1	1.40625
303.1	1.41368	311.1	1.40147

* Weston cell at 303.1°K = 1.0182v.



$$E_{298.1} = 1.0183 \text{ (224); } E = 1.0186 - 0.000038(t - 20) - 0.00000065(t - 20)^2 \text{ (1099); cf. (47, 48, 50, 680, 681, 684, 685, 686, 687, 688)}$$



$x(\text{H}_2\text{SO}_4)$	Total P	P (pure acid)	P (acid + Hg_2SO_4)	K'	ΔF
$T = 457.5^\circ\text{K}$					
0.2795	4.26	2.25	2.27	10.61	-2144
$T = 491.1^\circ\text{K}$					
0.300	11.60	4.20		119.6	-4662
0.2795	10.44	4.87	4.80	119.6	-4662
0.2102	8.56	7.85	7.76	35.6	-3482

$$K' = f_{(\text{H}_2\text{O})}^2 f_{(\text{SO}_2)}; \Delta F_{298.1} = 9\,540 \text{ (} x = 0.2795 \text{)}$$

Cu, Copper

Cu(g)

$$C_p = 5.0; \Delta H_{298.1}^0 = 66\,480; \Delta F_{298.1}^0 = 63\,210 \text{ (1186)}$$

Cu(l)

$$C_p = -4.5 + 0.008T \text{ (1186) from (1555, 1556); see Cu(s) = Cu(l)}$$

Cu(l) = Cu(g)

T	K	$\log K$	I^*	Lit.
2 148.1	0.0263	-1.580	24.17	(1274)
2 253.1	0.1315	-0.881	23.22	(510, 511, 512, 513)
2 298.1	0.0860	-1.066	24.97	(1274)
2 378.1	0.1631	-0.787	25.18	(1274)
2 448.1	0.275	-0.560	25.36	(1274)
2 453.1	0.338	-0.471	25.02	(510, 511, 512, 513)
2 488.1	0.395	-0.404	25.30	(1274)
2 518.1	0.532	-0.274	25.21	(1274)
2 573.1	0.988	-0.0052	25.02	(1274)
2 583.1	1.000	0	24.94	(510, 511, 512, 513)

* Calculated by Randall and Nielsen (1186) from ΔH_0^0 determined from vapor pressure data. Whence: $\Delta F^0 = 101\,700 - 9.5T \ln T + 0.004T^2 + 25.13T$; $\Delta H_{298.1}^0 = 104\,180$; $\Delta F_{298.1}^0 = 93\,410$.

Randall and Nielsen (1186) also calculated from above for $\text{Cu}(\text{s}) = \text{Cu}(\text{g})$, $\Delta S_{298.1}^0 = 45.95$; and from Lewis, Gibson and Latimer (868), $\text{Cu}(\text{s})$, $S_{298.1}^0 = 8.18$; and (859) $\text{Cu}(\text{g})$, $S_{298.1}^0 = 38.12$ (from theory of ultimate rational units); $\Delta S_{298.1}^0 = 29.94$; or for $\text{Cu}(\text{l}) = \text{Cu}(\text{g})$, $\Delta S_{298.1}^0 = 20.12$.

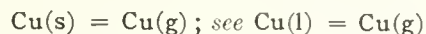
Using this value of $\Delta S_{298.1}^0$ and above values of the vapor pressure (1186) calculated values for ΔH_0^0 (average 62 440), and values for $\log P$ are consistent with the following equation. These values of $\log P$ are probably more reliable than the experimental values above. $\Delta H_0^0 = 62\,240$ gives $\Delta H_{2414.1}^0 = 62\,060$ in fair agreement with $\Delta H = 66\,900$ calculated by Hildebrand (622).

T	ΔH_0	$\log P$
2 148.1	65 302	-1.288
2 253.1	61 374	-0.982
2 298.1	64 577	-0.862
2 378.1	63 804	-0.664
2 448.1	63 112	-0.502
2 453.1	62 211	-0.489
2 488.1	62 237	-0.414
2 518.1	61 618	-0.347
2 573.1	60 288	-0.236
2 583.1	59 902	-0.214

$$\Delta F^0 = 62\,240 - 9.5T \ln T + 0.004T^2 + 41.12T; \Delta H_{298.1}^0 = 59\,250; \Delta F_{298.1}^0 = 58\,910. \text{ This value probably better than } 93\,410 \text{ above.}$$

Cu(s)

$\Delta F^0, \Delta H^0 = 0$ (853, 873); $C_p = 5.46 + 0.0072T$ (1186) from (346, 1043, 1333, 1555, 1556)

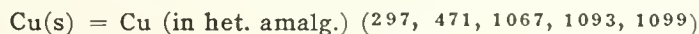


Cu(s) = Cu(l)

$\Delta F^0 = 9\,895 + 9.96T \ln T - 0.0034T^2 - 74.52T$; $\Delta F_{298.1}^0 = 4\,300$; $\Delta H_{298.1}^0 = 7\,228$ (1186) from (492, 1215, 1555, 1556)

Cu⁺⁺

$E_{298.1}^0 = -0.3448$; $\Delta F_{298.1}^0 = 15\,912$ (885) from (873)

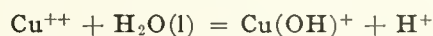


CuO(s)

$\Delta F^0 = -37\,280 + 0.39T \ln T - 0.0027T^2 + 21.981T$; $\Delta H_{298.1}^0 = 37\,160$; $\Delta F_{298.1}^0 = -30\,300$ (1186)

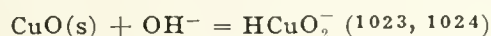
CuO(s) = CuO(l)

$\Delta F^0 = 13\,300 - 8.264T$; $\Delta F_{1609}^0 = 0$; $\Delta F_{298.1}^0 = 10\,836$ (1186)

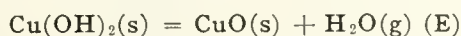


c	% Hydrolysis in CuCl ₂ (aq) (800)	
	358.6°K	373.1°K
0.00392	0.515	0.888
.0157	.375	.612
.0625	.276	.407
.25	.252	.313

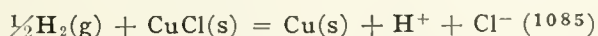
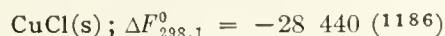
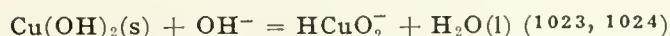
In Cu(NO ₃) ₂ (aq) (800)		
0.00392	0.660	1.02
.0156	0.530	0.648
.0625		0.368
.248		0.231

Cu(OH)₂(s)

$\Delta F_{298.1}^0 = -85\,090$ (1186) from (13)

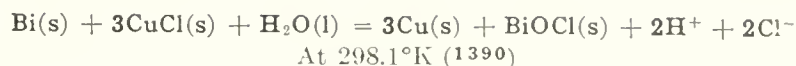
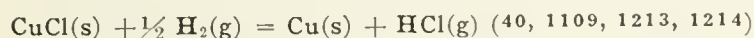


$P_{298.1} = 0.0001$ (13); $= 0.0011$ (430)



T	m(HCl)	E
298.1	0.01447	0.34718
308.1	.01447	.34643
298.1	.04304	.29227
288.1	.09596	.25340
298.1	.09596	.25204
308.1	.09596	.25049
288.1	.1876	.22134
298.1	.1876	.21911
308.1	.1876	.21663
298.1	.3253	.19158
308.1	.3253	.18823
298.1	.6310	.15798

T.....	288.1	298.1	308.1
E ⁰	0.1274	0.1216	0.1156

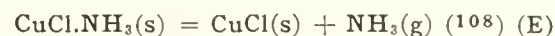


c(ΣCl)	c(ΣCu)	c(ΣBi)
0.977	0.0499	0.0615
1.939	.0642	.2640
0.594	.0345	.0117
0.594	.0341	.0114
0.537	.0239	.0087
0.902	.0468	.0484
0.818	.0456	.0449
1.243	.0560	.1075
1.176	.0543	.0958
0.258	.0171	Trace
0.229	.0134	Trace

At 348.1°K (1085)

$K_{348.1} = 2.10 \times 10^{-3}$; $\Delta H = -7\,390$

c(ΣCl)	c(ΣCu)	c(ΣBi)	c(ΣH)
0.4059	0.0762	0.0033	0.3198
.4186	.0781	.0044	.3273
.4087	.0769	.00225	.3251
.4079	.0765	.00196	.3255

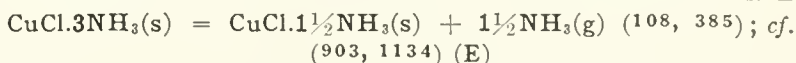


T	P	T	P
305.8	0.000047	349.4	0.00186
336.0	0.00066	417.6	0.132 (extrap.)

$\Delta H = 16\,730$



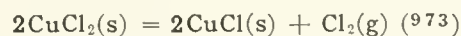
T	P	T	P
305.8	0.033	349.4	0.532
336.0	0.241		$\Delta H = 6\,305$



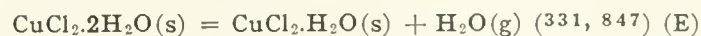
T	P	T	P
273.1*	0.078	307.6	0.568
286.1*	0.158	315.3	0.822
288.1	0.200	317.6	0.928
301.6	0.421	318.1	0.949
305.8*	0.450	320.1	1.034

$\Delta H = 14\,220^*$

* From (108); all other values from (385).

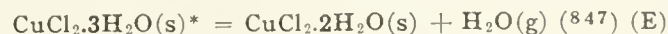


T	P	T	P
739.4	0.1374	774.1	0.5032
769.4	.3937		



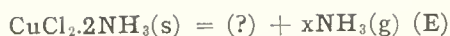
T	P	T	P
291.0	0.0049	333.1*	0.120
299.7	0.0114	337.28	0.1389
304.5	0.0154	338.1*	0.153
312.9	0.0247	343.1*	0.200
326.64	0.0714	353.1*	0.322

* From (847); all other values from (331).



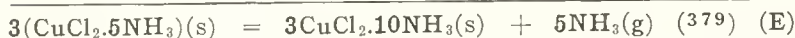
T	P	T	P
353.1	0.082	373.1	0.243
363.1	0.141		

* The existence of the trihydrate is questionable.

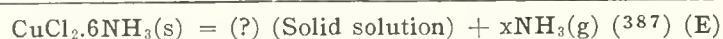


$$P_{543.1} = 1.000 \text{ (387)}$$

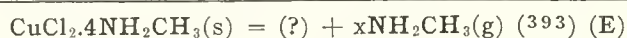
$3\text{CuCl}_2 \cdot 10\text{NH}_3(\text{s}) = 3(\text{CuCl}_2 \cdot 2\text{NH}_3)(\text{s}) + 4\text{NH}_3(\text{g}) \text{ (E)}$ $P_{397.1} = 0.938 \text{ (387)}$			
T	P	T	P
336.6	0.150	368.5	0.668
344.6	0.237	373.1	0.804
351.6	0.332	377.6	0.964
358.1	0.425	378.1	1.000
361.6	0.500	$\Delta H = 68\,000$	



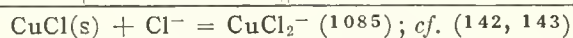
T	P	T	P
336.6	0.150	368.5	0.668
344.6	0.237	373.1	0.804
351.6	0.332	377.6	0.964
358.1	0.425	378.1	1.000
361.6	0.500	$\Delta H = 68\,000$	



Moles NH_3	T at which $P = 0.938$	Moles NH_3	T at which $P = 0.938$
5.76	289.1	5.17	353.1
5.49	323.1	5.13	363.1
5.23	343.1	5.08	376.1

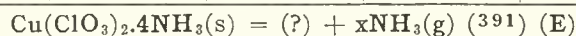


T	P	T	P
323.6	0.086	372.1	0.645
337.6	0.141	381.6	0.888
355.6	0.306	385.6	1.026
364.1	0.454	$\Delta H = 13\,770\text{x}$	

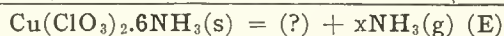


In $\text{HCl}(\text{aq})$ at 298.1°K

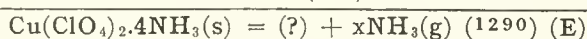
$c(\text{HCl})$	$c(\Sigma\text{Cl})$	$c(\Sigma\text{Cu})$	K_c	$\mu_c^{1/2}$
1.1650	1.2815	0.1165	0.1111	1.080
0.3165	0.3365	0.01988	0.0671	0.562
.2156	.2290	.01340	.0662	.464
.0978	.1038	.00595	.0650	.313



T	P	T	P
370.1	0.047	420.1	0.592 (extrap.)
389.1	0.072	424.1	0.717 (extrap.)
415.5	0.461	431.1	1.000 (extrap.)
$\Delta H = 15\,600\text{x}$			



$P_{284.1} = 0.938$; $\Delta H = 9\,800\text{x}$; solid solution results upon decomposition (391)

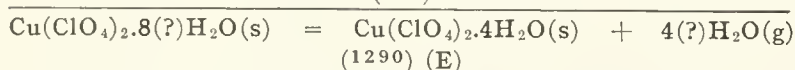


T	P	T	P
387.1	0.0143	462.1	0.0518
399.1	0.016	467.1	0.062
422.1	0.0182	484.1	0.101
431.1	0.0230	498.1	0.237
439.1	0.0267	543.1	1.000*
452.1	0.0431	$\Delta H = 20\,000\text{x}$	

* Extrapolated from (390).

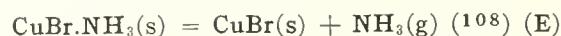


$P_{330.1} = 1.000$; $\Delta H = 11\,600\text{x}$; solid solution upon decomposition (390)



T^*	P	T^*	P
355.1	0.0129	421.1	0.0216
366.1	0.0187	456.1	0.0216
400.1	0.0187	462.1	0.0274
411.1	0.0201	472.1	0.0792

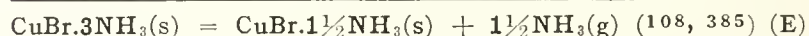
* At 373.1° , changes into the tetrahydrate; at 420.1° basic salt forms; at 456.1° decomposition begins.



T	P	T	P
317.1	0.0033	349.9	0.041
336.4	0.017	359.1	0.132 (extrap.)
$\Delta H = 14\,640$			



T	P	T	P
306.1	0.013	349.9	0.230
336.4	0.118	371.1	0.774
$\Delta H = 6\,575$			

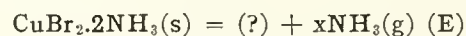


T	P	T	P
283.1	0.132*	306.1	0.442
285.1	0.151	313.6†	0.684
286.5†	0.158	317.1	0.733
296.1	0.263*	322.1†	0.974
305.1†	0.434	$\Delta H = 14\,250$	

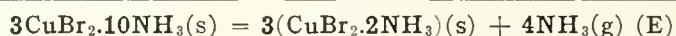
* Interpolated. † From (385); all other values from (108).



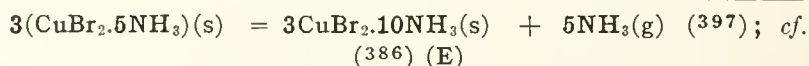
T	P	T	P
439.1	0.0041	523.1	0.2447
453.2	.0089	539.4	.4651
486.1	.0474	554.1	.8085
505.4	.1118		



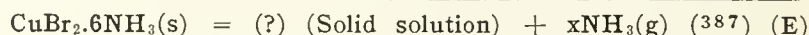
$$P_{533.1} = 0.938 \text{ (387)}$$



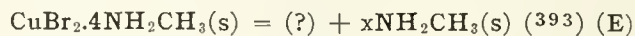
Freshly prepared substance, $P_{439.1} = 0.938$; previously heated substance, $P_{428.1} = 0.938 \text{ (387)}$



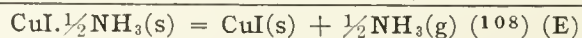
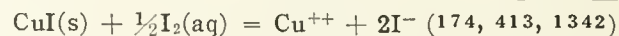
T	P	T	P
296.1	0.007	377.6	0.618
331.1	0.072	382.9	0.766
345.6	0.151	387.6	0.895
357.1	0.259	392.1	1.037
369.6	0.421	$\Delta H = 70\,000$	



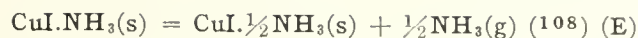
Moles NH_3 in substance	T at which $P = 0.938$	Moles NH_3 in substance	T at which $P = 0.938$
6.04	273.1	5.28	354.1
5.89	288.1	5.19	364.1
5.82	305.1	5.15	376.1
5.65	324.1	5.08	388.1
5.48	338.1		



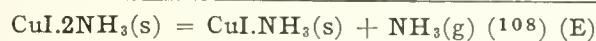
T	P	T	P
337.6	0.079	379.1	0.618
349.6	0.191	384.6	0.776
362.6	0.330	392.6	1.019
372.1	0.476	396.1	1.138
$\Delta H = 14\,000\text{x}$			



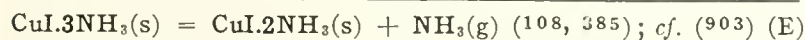
T	P	T	P
371.1	0.047	409.1	0.370
382.1	0.0769	$\Delta H = 7\,610$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
349.7	0.039	382.1	0.228
371.1	0.124	$\Delta H = 7\,350$	

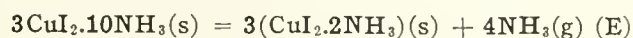


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
281.1	0.037	305.9	0.213
286.1	0.055	317.1	0.426
$\Delta H = 11\,300$			

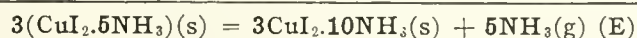


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
263.1*	0.025	305.9*	0.425
285.9*	0.121	316.6	0.739
290.1	0.174	322.1	0.961
303.3	0.371	$\Delta H = 10\,370^*$	

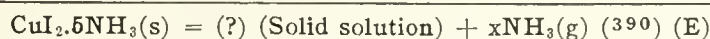
* From (108); all other values from (385).



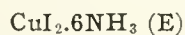
$$P_{420.1} = 0.938 \quad (387)$$



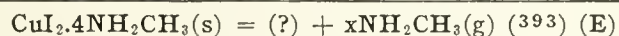
$$P_{392.6} = 0.938; \Delta H = 41\,000 \quad (387)$$



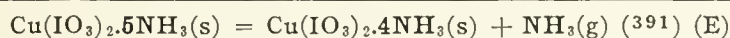
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
329.1	0.061	371.1	0.395
349.1	0.129	379.1	0.563
359.1	0.205	386.6	0.758
363.1	0.262	393.1	0.991
366.1	0.313		



Ephraim (387) gives $P = 0.94$ at *ca.* 303°K



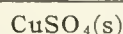
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
330.1	0.092	385.6	0.641
340.6	0.138	392.1	0.816
349.6	0.184	397.6	1.000
361.6	0.267	402.6	1.182
376.1	0.454	$\Delta H = 14\,240x$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.6	0.186	355.1	0.842
338.1	0.342	357.6	0.946
348.1	0.579	$\Delta H = 12\,700$	



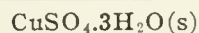
$$C_p = 12.03 + 0.001T \quad (158, 1186); \Delta F^0 = -12\,120 - 2.45T \ln T + 0.0025T^2 + 14.89T; \Delta H_{298.1}^0 = -11\,610; \Delta F_{298.1}^0 = -11\,620 \quad (158)$$



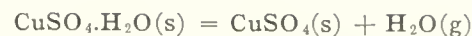
$$C_p = 24.09 \quad (1325); \Delta F^0 = -182\,360 + 0.8T \ln T + 84.322T; \Delta H_{298.1}^0 = -182\,600, \Delta F_{298.1}^0 = -155\,850 \quad (1186)$$



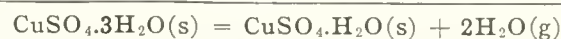
$$C_p = 31.08 \quad (1325); \Delta F^0 = 256\,360 + 3.24T \ln T + 0.00165T^2 - 0.00000037T^3 + 114.418T; \Delta H_{298.1}^0 = -257\,460; \Delta F_{298.1}^0 = -216\,610 \quad (1186)$$



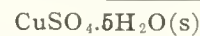
$$C_p = 48.88 \quad (1325); \Delta F^0 = -398\,600 + 5.12T \ln T + 0.00495T^2 - 0.00000111T^3 + 194.448T; \Delta H_{298.1}^0 = -400\,520; \Delta F_{298.1}^0 = -331\,530 \quad (1186)$$



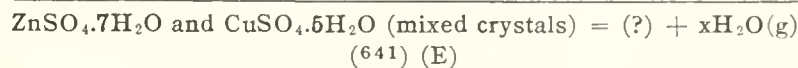
$$\Delta F^0 = 16\,590 - 1.5T \ln T - 26.125T \quad (\text{range } 298 \text{ to } 493^\circ\text{K}); \Delta H_{298.1}^0 = 17\,040; \Delta F_{298.1}^0 = 6\,255 \quad (1186) \text{ from } (430, 843, 844, 1325, 1350)$$



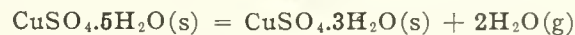
$$\Delta F^0 = 27\,420 - 72.190T \quad (\text{range } 298 \text{ to } 373^\circ\text{K}); \Delta F_{298.1}^0 = 5\,900 \quad (1186) \text{ from } (257, 458, 843, 844)$$



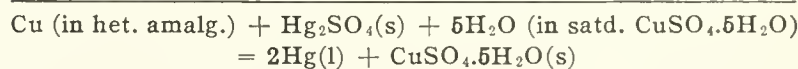
$$C_p = 67.15 \quad (1325); \Delta F^0 = -539\,970 + 7.00T \ln T + 0.00825T^2 - 0.00000185T^3 + 273.164T; \Delta H_{298.1}^0 = -542\,710; \Delta F_{298.1}^0 = -445\,960 \quad (1186)$$



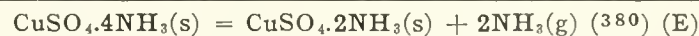
Mole % ZnSO ₄	<i>P</i> at which <i>T</i> = 293.1 ± 0.2°	Mole % ZnSO ₄	<i>P</i> at which <i>T</i> = 293.1 ± 0.2°
Rhombic (7H ₂ O)		Triclinic (5H ₂ O)	
100.0	0.0138	11.6	0.0050
97.8	0.0129	2.8	0.0063
		0.0	0.0076
Monoclinic (7H ₂ O)			
74.6	0.0122		
64.7	0.0123		



$$\Delta F^0 = 26\,550 - 70.876T \quad (\text{range } 283 \text{ to } 373^\circ\text{K}); \Delta F_{298.1}^0 = 5\,420 \quad (1186) \text{ from } (257, 430, 458, 641, 843, 844, 895, 1090, 1113, 1114, 1335, 1531)$$



$$\Delta H_{298.1} = -24\,710; \Delta F_{298.1} = -15\,995 \quad (1186) \text{ from } (297, 1093, 1099)$$

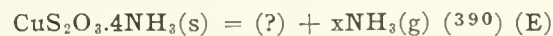


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
393.1	0.082	433.6	0.661
410.1	0.162	439.6	0.875
424.6	0.421	441.6	0.948

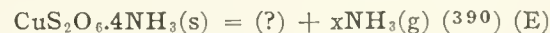
$$\Delta H = 32\,160 \quad (380); P_{414.6} = 0.938 \quad (387)$$



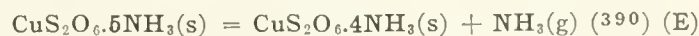
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.004	368.1	0.761
343.1	0.162	373.1	0.949
360.6	0.470	$\Delta H = 12\,830$	



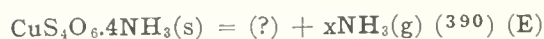
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
339.1	0.136	354.1	decomposes
350.1	0.155		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
385.1	0.032	457.1	0.110
422.1	0.045	523.1	1.000 (extrap.)
444.1	0.054	$\Delta H = 19\,300x$	

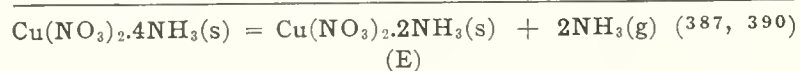
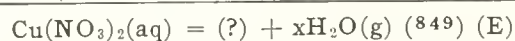


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
253.1	0.079	282.1	0.462
260.1	0.149	287.1	0.599
264.1	0.188	292.1	0.770
269.1	0.241	299.1	1.045
274.1	0.312	$\Delta H = 10\,400$	

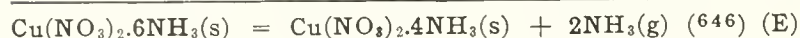


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.6	0.007	355.1	0.316
323.1	0.115	362.1	0.632
338.1	0.154	366.1	0.991

$$\Delta H = 13\,000x$$

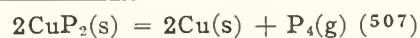
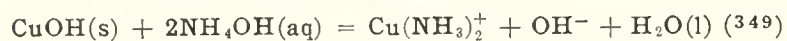


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
416.1	0.086	448.6	0.336
426.6	0.112	479.1	1.000
437.6	0.207		$\Delta H = 34\,800$

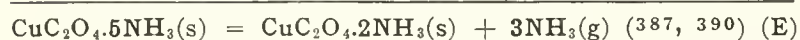


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
236.6	0.029	288.5*	0.996
237.1	0.046	288.9	0.997
256.6	0.158	296.5	1.282
263.7	0.316	302.4	1.572
270.6	0.509	308.5	1.908
271.6	0.514	316.5	2.500
281.0	0.722	323.6	3.088

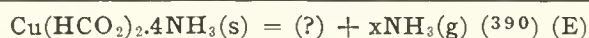
* According to (387), $P_{288.1} = 0.938$.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
718.1	0.0097	793.1	0.1226
728.1	.0150	803.1	.1237
758.1	.0180	843.1	.1313
768.1	.0218		

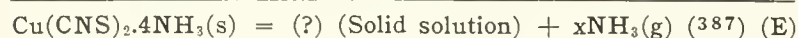


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
294.1	0.387	310.1	0.938
300.1	0.576	311.1	1.037
305.1	0.786		

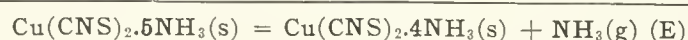


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
260.1	0.012	293.1	0.087
268.1	0.020	301.1	0.129
271.1	0.025	309.1	0.242
284.1	0.054	332.1	1.000 (extrap.)

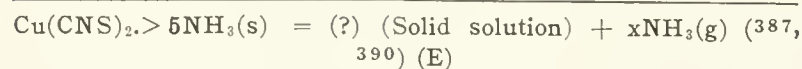
$\Delta H = 11\,700x$; at 310° the compound changes into another form



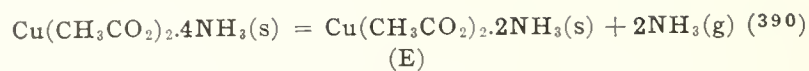
Moles NH_3	<i>T</i> at which <i>P</i> = 0.938	Moles NH_3	<i>T</i> at which <i>P</i> = 0.938
4.00	373.1	2.23	388.1
2.55	381.1	2.00	400.1 (decomposes)



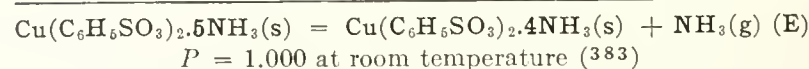
$$P_{276.1} = 0.938 \quad (387)$$



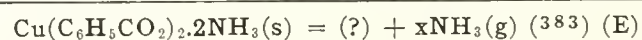
Moles NH_3	<i>T</i> at which <i>P</i> = 0.938	Moles NH_3	<i>T</i> at which <i>P</i> = 0.938
5.50	255.1	5.05	266.1
5.16	260.1		



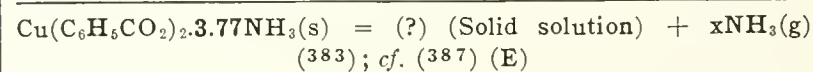
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.007	331.1	0.437
297.6	0.059	338.1	0.572
310.1	0.130	346.1	0.812
317.1	0.207	348.1	0.938 (387)
324.1	0.312	351.1	1.013



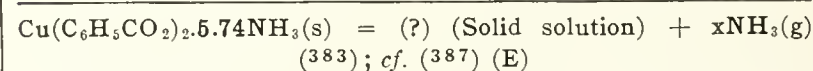
$$P = 1.000 \text{ at room temperature } (383)$$



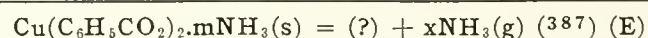
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
396.1	0.067	453.1	0.856
426.1	0.230	456.1	1.000 (decomposes)
448.1	0.618		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
317.1	0.099	345.1	0.629
328.1	0.237	354.1	0.928
339.1	0.466	355.6	1.000



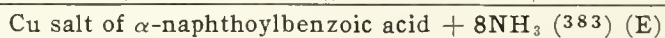
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
266.1	0.188	285.1	0.888
273.1	0.436	285.6	0.912
275.1	0.483	287.1	1.000
278.1	0.591		



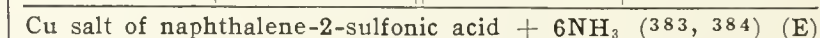
Moles NH_3	<i>T</i> at which <i>P</i> = 0.938	Moles NH_3	<i>T</i> at which <i>P</i> = 0.938
8.32	260.1	4.08	323.1
8.27	268.1	4.05	343.1
5.99	273.1	3.77	355.1
5.85	282.1	2.31	362.1
5.74	289.1	2.15	371.1
4.12	293.1	2.10	400.1
4.10	305.1	2.08	443.1

At a pressure of 0.938 the octammine is stable at 270.1°K; at a little above 270.1°K, the hexammine is stable.

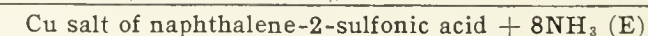
Solid soln., Moles NH_3	<i>T</i>	Solid soln., Moles NH_3	<i>T</i>
6 -5.74	270.1-288.1	4 -3.77	351.1-354.1
5.74-4.12	288.1-293.1	3.77-2.31	354.1-361.1
4.12-4	293.1-351.1	2.31-2.0	361.1-453.1



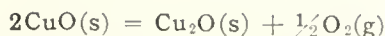
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
266.1	0.192	281.6	0.487
268.1	0.237	285.1	0.632
272.1	0.309	289.1	0.855
277.1	0.408	289.1	0.968



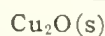
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
339.1	0.599	352.1	0.963
346.1	0.780	352.6	1.000



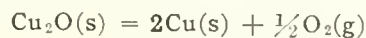
$P_{272.1} = 1.000$ (383, 384); for ammoniates of Cu salts of sulfanilic, phthalic, trinitrobenzoic, naphthalic, naphthalene-1-sulfonic, dibromonaphthalene-2-sulfonic acids, see (383, 384)



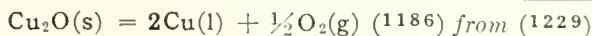
$$\Delta F^0 = 33\,550 - 0.95T \ln T + 0.00375T^2 - 22.340T \text{ (range 1111 to } 1358^\circ\text{K)}; \Delta H_{298.1}^0 = 33\,510; \Delta F_{298.1}^0 = 25\,610 \text{ (1186) from (431, 1229, 1391, 1537)}$$



$$\Delta F^0 = -41\,150 - 0.17T \ln T - 0.0033T^2 + 22.583T; \Delta H_{298.1}^0 = -40\,810; \Delta F_{298.1}^0 = -35\,000 \text{ (1186)}$$

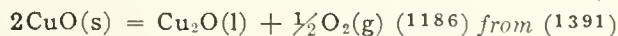


$$\Delta F^0 = 41\,150 + 0.17T \ln T + 0.0033T^2 - 22.583T; \Delta H_{298.1}^0 = 40\,810; \Delta F_{298.1}^0 = 35\,000 \text{ (1186)}$$

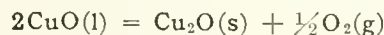


$$\Delta F^0 = 60\,940 + 20.09T \ln T - 0.0035T^2 - 171.6T; \Delta H_{298.1}^0 = 55\,270; \Delta F_{298.1}^0 = 43\,600$$

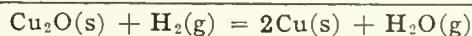
T	P	xT	K
1 392.3	0.0000368	0.975	0.00577
1 423.5	0.0000460	0.965	0.00632
1 457.7	0.0000540	0.953	0.00666



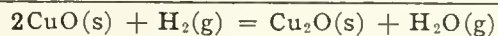
$$\Delta F = 51\,950 - 0.95T \ln T + 0.00375T^2 - 34.533T \text{ (range 1356 to } 1505^\circ\text{K)}; \Delta H^0 = 51\,900; \Delta F_{298.1}^0 = 40\,410$$



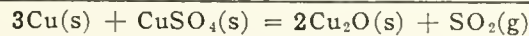
$$\Delta F^0 = 6\,950 - 0.95T \ln T + 0.00375T^2 - 5.812T \text{ (range 1357 to } 1506^\circ\text{K)}; \Delta H = 6\,900; \Delta F_{298.1}^0 = 3\,938 \text{ (1186) from (1391)}$$



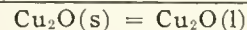
$$K_{723.1} = 16.7 \text{ to } 19.0 \text{ (1538)}$$



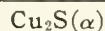
$$K_{723.1} = 26.3 \text{ to } 30.1 \text{ (1538); cf. (304, 491)}$$



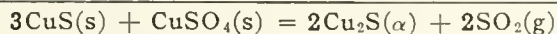
$$\Delta F^0 = 32\,400 - 53.614T \text{ (range 525 to } 588^\circ\text{K)}; \Delta F_{298.1}^0 = 16\,420 \text{ (1186) from (1310)}$$



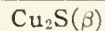
$$\text{M.P.} = 1236^\circ\text{C}; \Delta F^0 = 18\,400 - 12.193T; \Delta F_{298.1}^0 = 14\,760; \Delta H = 18\,400 \text{ (1186)}$$



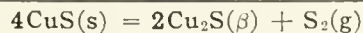
$$C_p = 6.75 + 0.039T; \Delta F^0 = -17\,920 + 8.29T \ln T - 0.0160T^2 - 46.46T; \Delta H_{298.1}^0 = -18\,970; \Delta F_{298.1}^0 = -19\,110 \text{ (1186) from (75)}$$



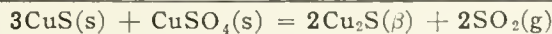
$$P_{868.1} = 0.2368; \Delta F^0 = 46\,940 + 6.17T \ln T - 158.25T; \Delta H_{298.1}^0 = 45\,100; \Delta F_{298.1}^0 = 10\,245 \text{ (1186) from (1204)}$$



$$C_p = 20.45 + 0.0145T; \Delta F^0 = -20\,440 - 5.41T \ln T - 0.0037T^2 + 36.86T; \Delta H_{298.1}^0 = -18\,500; \Delta F_{298.1}^0 = -18\,970 \text{ (1186) from (75)}$$



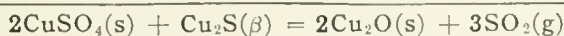
$$\Delta F^0 = 38\,160 + 0.72T \ln T - 0.013T^2 - 39.56T \text{ (range 666 to } 775^\circ\text{K)}; \Delta H_{298.1}^0 = 39\,100; \Delta F_{298.1}^0 = 26\,820 \text{ (1186) from (12, 1158, 1508)}$$



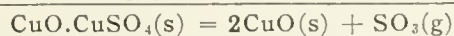
$$\Delta F^0 = 41\,890 - 6.37T \ln T - 55.25T \text{ (range 394 to } 448^\circ\text{K)}; \Delta H_{298.1}^0 = 43\,730; \Delta F_{298.1}^0 = 14\,600 \text{ (1186) from (1204)}$$



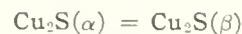
$$\Delta F^0 = 34\,480 + 9.37T \ln T + 0.0063T^2 - 105.212T \text{ (range, 781 to } 1324^\circ\text{K)}; \Delta H_{298.1}^0 = 31\,130; \Delta F_{298.1}^0 = 19\,590 \text{ (1186) from (1204, 1310, 1412)}$$



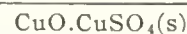
$$\Delta F^0 = 99\,280 + 13.37T \ln T - 233.52T \text{ (range 433 to } 673^\circ\text{K)}; \Delta H_{298.1}^0 = 95\,290; \Delta F_{298.1}^0 = 52\,370 \text{ (1186) from (1204, 1310)}$$



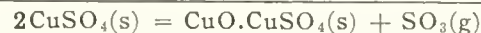
$$\Delta F^0 = 53\,970 + 1.25T \ln T - 54.617T \text{ (range 1013 to } 1093^\circ\text{K)}; \Delta H_{298.1}^0 = 54\,010; \Delta F_{298.1}^0 = 39\,810 \text{ (1186) from (1204)}$$



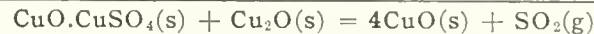
$$\Delta F_{376.1}^0 = 0; \Delta H_{376.1}^0 = 896; \Delta F^0 = -2\,520 - 13.7T \ln T + 0.0123T^2 + 83.32T; \Delta H_{298.1}^0 = 470; \Delta F_{298.1}^0 = 140 \text{ (1186) from (75)}$$



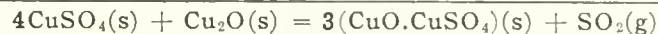
$$\Delta H^0 = -219\,090 \text{ (1186) from (1204)}; \Delta F^0 = -219\,090 - 0.37T \ln T + 112.31T; \Delta H_{298.1}^0 = -218\,980; \Delta F_{298.1}^0 = -186\,240 \text{ (1186)}$$



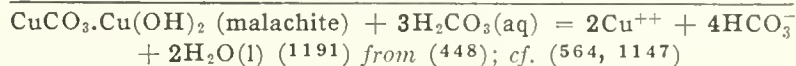
$$\Delta F^0 = 55\,080 + 1.25T \ln T - 58.546T \text{ (range 953 to } 1053^\circ\text{K)}; \Delta H_{298.1}^0 = 55\,120; \Delta F_{298.1}^0 = 39\,750 \text{ (1186) from (1204); cf. (455, 636, 835)}$$



$$\Delta F^0 = 43\,020 - 40.676T \text{ (range 917 to } 1027^\circ\text{K)}; \Delta F_{298.1}^0 = 30\,895 \text{ (1186) from (1204)}$$



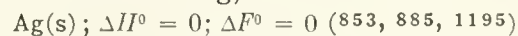
$$\Delta F^0 = 45\,240 - 48.673T \text{ (range 825 to } 921^\circ\text{K)}; \Delta F_{298.1}^0 = 30\,730 \text{ (1186) from (1204)}$$



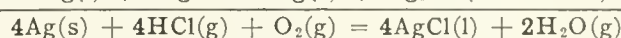
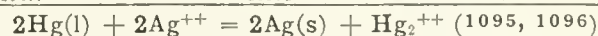
$$\log p.f._{303.1} = 2.316; \Delta F_{303.1}^0 = 19\,285; \Delta H = -9\,200; K_{298.1} = 1.64 \times 10^{-14}; \Delta F_{298.1}^0 = 18\,815$$

$m(\text{H}_2\text{CO}_3)$	$m(\text{Cu}^{++})$	$m(\text{NaCl})$	$\mu^{1/2}$	$\log(1/K_m^{1/6})$
0.00338	0.000131		0.019	2.4465
.00598	.000215		.025	2.3553
.00751	.000267		.028	2.3106
.01630	.000404		.035	2.2990
.01890	.000440		.036	2.2941
.02110	.000489		.038	2.2722
.02558	.000531		.040	2.2782
.02703	.000548		.041	2.2765
.02804	.000555		.041	2.2790
.03431	.000625		.043	2.2711
.03107	.000598	0.000171	.044	2.2687
.00482	.000241	.00171	.049	2.2588
.02555	.000551	.000856	.050	2.2618
.01923	.000461	.00171	.056	2.2770
.02254	.000550	.00171	.058	2.2350
.02936	.000559	.00171	.058	2.2860
.03575	.000583	.00171	.059	2.3102
.02766	.000614	.00857	.102	2.2320
.02796	.000924	.1729	.420	2.0574

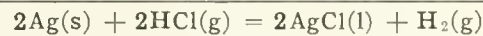
Ag, Silver



$$\text{Ag}^+; E_{298.1}^0 = -0.7995; \Delta F_{298.1}^0 = 18\,448 \text{ (885) from (853, 1079)}$$

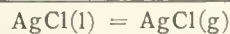


$$K_{1173.1} = 0.15 \times 10^{14}; K_{1273.1} \text{ for liquid Ag} = 0.29 \times 10^{12} \text{ (161)}$$

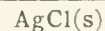


$$\Delta F^0 = -8\,560 - 0.9T \ln T + 0.00005T^2 + 22.44T \text{ (161) from (739, 740, 741, 742)}$$

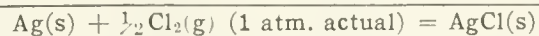
T	K	T	K
799	0.044	978	0.018
878	.030		



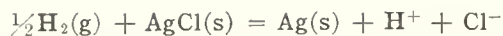
$$\log P \text{ (1200-1400}^\circ\text{K)} = -7\,625/T + 3.651 \text{ (161)}$$



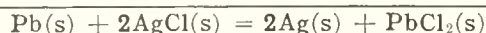
$$E_{298.1}^0 = 1.1363; \Delta F_{298.1}^0 = -26\,220 \pm 5 \text{ (1189) from (470); cf. (888, 1195, 1548)}$$



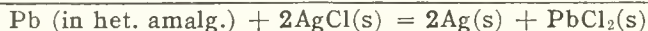
$$E = 1.1511 - 0.000595t; E_{298.1} = 1.1362 \text{ (470). } E = 1.1451 - 0.000672t; E_{298.1} = 1.1284 \text{ (1548)}$$



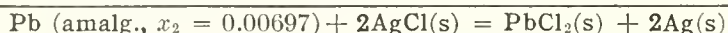
$E_{298.1}^0 = 0.2234$; $\Delta F_{298.1}^0 = -5155$ (885). $E_{298.1}^0 = 0.2221$; $\Delta F_{298.1}^0 = -5125$ (1195) (revised value) from (527, 581, 582, 584, 648, 900, 1072, 1081, 1299, 1300)



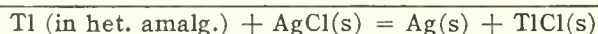
$E_{298.1}^0 = 0.4905$ (193); $E^0 = 0.49493 - 0.000189t$; $E_{298.1}^0 = 0.49019$ (470); $E^0 = 0.4915 - 0.00012t$; $E_{298.1}^0 = 0.4885$ (530); $E^0 = 0.4958 - 0.000124t$; $E_{298.1}^0 = 0.4927$ (amorphous and fused AgCl) (792)



$E_{298.1} = 0.4833$ (stick lead "amalgamated") (14); $E_{298.1} = 0.4841$ (plated Ag and AgCl) (256); $E_{298.1} = 0.48941 - 0.000203t$; $E_{298.1} = 0.48433$ (470)



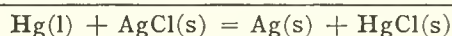
$E = 0.4865 - 0.00003981t$; $E_{298.1} = 0.4765$ (plated Ag and AgCl) (193). $E = 0.4765 - 0.000004t$; $E_{298.1} = 0.47638$ (1429)



$E_{298.1} = 0.7766$; $dE/dt = -0.0000794/\text{deg.}$ (470)

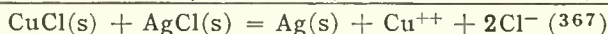
$\text{Cd}(\text{in het. amalg.}) + 2\text{AgCl}(\text{s}) + 2\frac{1}{2}\text{H}_2\text{O}(\text{in satd. CdCl}_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}) = 2\text{Ag}(\text{s}) + \text{CdCl}_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}(\text{s})$; $E = 0.6249 - 0.000004t$; $E_{298.1} = 0.62478$ (1429)

$\text{Cd}(\text{amalg., } x_2 = 0.0792) + 2\text{AgCl}(\text{s}) + 2\frac{1}{2}\text{H}_2\text{O}(\text{in satd. CdCl}_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}) = 2\text{Ag}(\text{s}) + \text{CdCl}_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}(\text{s})$; $E_{298.1} = 0.62203$ (648)

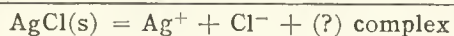


$E^0 = A + Bt$

A	B	$E_{298.1}^0$	Remarks	Lit.
0.0385	0.00035	0.0473	Plated Ag and AgCl	(187)
0.0365	0.000362	0.0455		(196)
0.03705	0.000338	0.0455	In KCl, in <i>m</i> HCl	(470)
		0.0455	In HCl and KCl	(1195)
0.0362	0.000336	0.0446		(1548)



$m(\text{Cu}^{++})$	$m(\text{CuCl}_2)$	$m(\text{Cl}^-)$	$m(\text{Cu}^+)$	μ
$T = 298.1^\circ\text{K}$				
0.00976	0.00160	0.02402	0.00015	0.0354
.00813	.00178	.02694	.00007	.0368
.00411	.00265	.0399		.0466
.00134	.00558	.08405		.0910
.00057	.01145	.1743		.1863
.00048	.01503	.2224		.2375
.00038	.01800	.2733		.2920
$T = 313.1^\circ\text{K}$				
0.01042	0.00236	0.02168	0.00059	0.0345
.00814	.00264	.02422	.00050	.0350
.00571	.00334	.03071	.00056	.0398
.00317	.00466	.04277	.00034	.0506
.00200	.00634	.05813	.00027	.0665
.00124	.00890	.0826		.0927
.00100	.01093	.0987		.1106
.000832	.0173	.1675		.1852



In HCl(aq) at 298.1°K (432, 433)

$C(\text{HCl})$	$C(\Sigma\text{Ag} \times 10)$	$C(\text{HCl})$	$C(\Sigma\text{Ag} \times 103)$
0.00478	0.00075	0.9258	0.0719
.00938	.00084	1.300	.126
.0178	.00125	1.911	.266
.0341	.00219	2.149	.374
.0741	.00361	2.569	.610
.0914	.00426	2.975	.814
.3167	.01403	3.576	1.358
.649	.032	4.182	2.147
.6818	.0448	4.735	3.168
.7797	.0559	5.508	5.126

AgCl(s).—(Continued)
In HNO₃(aq) at 298.1°K (498)

$C(\text{HNO}_3)$	$C(\Sigma\text{Ag} \times 10^3)$	$C(\text{HNO}_3)$	$C(\Sigma\text{Ag} \times 10^3)$
0.0005	1.15	0.3	1.57
.001	1.19	1.5	1.71
.01	1.24		

In NH₄Cl(aq) at 298.1°K (432, 498); cf. (433, 1316)

$C(\text{NH}_4\text{Cl})$	$C(\Sigma\text{Ag} \times 10^3)$	$C(\text{NH}_4\text{Cl})$	$C(\Sigma\text{Ag} \times 10^3)$
0.00001	0.0112 (498)	2.918	2.160
.0001	.0166 (498)	3.162	2.795
.513	.042	3.510	4.029
.926	.113	4.363	9.353
1.141	.172	4.902	14.92
1.574	.365	5.503	24.04
2.143	.842	5.764	30.17
2.566	1.425		

In NH₄NO₃(aq), $c = 0.01$ (1261)

$T, ^\circ\text{K}$	$C(\Sigma\text{Ag})$	$T, ^\circ\text{K}$	$C(\Sigma\text{Ag})$
291.1	1.04×10^{-5}	298.1	1.43×10^{-5}

In Hg(NO₃)₂(aq) at 298.1°K (1019)

$C(\text{Hg}(\text{NO}_3)_2)$	$C(\Sigma\text{Ag})$	$C(\text{Hg}(\text{NO}_3)_2)$	$C(\Sigma\text{Ag})$
0.01	0.00432	0.05	0.00914
.0125	.00499	.1	.01395
.025	.00690	1.0	.04810

In AgNO₃(aq) at room temperature (432); cf. (917)

$C(\text{AgNO}_3)$	$C(\Sigma\text{Cl} \times 10^3)$
2.0	0.03

In ZnCl₂(aq) at 298.1°K (432)

$C(\text{ZnCl}_2)$	$C(\Sigma\text{Ag} \times 10^3)$
1.694	0.364

In CaCl₂(aq) at 298.1°K (432); cf. (433)

$C(\text{CaCl}_2)$	$C(\Sigma\text{Ag} \times 10^3)$	$C(\text{CaCl}_2)$	$C(\Sigma\text{Ag} \times 10^3)$
0.874	0.289	1.868	2.182
1.100	.501	2.016	2.802
1.370	.900	2.269	4.175
1.632	1.463	2.503	5.823

In SrCl₂(aq) at 298.1°K (432); cf. (433)

$C(\text{SrCl}_2)$	$C(\Sigma\text{Ag} \times 10^5)$	$C(\text{SrCl}_2)$	$C(\Sigma\text{Ag} \times 10^5)$
0.275	0.033	1.238	0.747
.494	.092	1.496	1.252
.679	.173	1.747	2.018
.786	.236	1.797	3.594
.849	.284	4.087	8.174
.909	.348	6.02	12.04
1.070	.510		

In BaCl₂(aq) at 298.1°K (432)

$C(\text{BaCl}_2)$	$C(\Sigma\text{Ag} \times 10^3)$	$C(\text{BaCl}_2)$	$C(\Sigma\text{Ag} \times 10^3)$
0.624	0.186	1.338	1.274
.805	.339	1.630	2.366

In NaCl(aq) at 298.1°K (432, 433); cf. (917)

$C(\text{NaCl})$	$C(\Sigma\text{Ag} \times 10)$	$C(\text{NaCl})$	$C(\Sigma\text{Ag} \times 10^3)$
0.00386	0.00072	0.9747	0.0806
.00924	.00091	1.190	.130
.01758	.00131	1.433	.184
.03654	.00189	1.617	.245
.08844	.00361	1.871	.348
.3556	.0174	2.094	.446
.5112	.0280	2.272	.570
.933	.086	2.449	.684

AgCl(s).—(Continued)

$C(\text{NaCl})$	$C(\Sigma\text{Ag} \times 10^3)$	$C(\text{NaCl})$	$C(\Sigma\text{Ag} \times 10^3)$
2.658	0.851	3.977	2.879
2.841	1.040	4.170	3.335
3.000	1.194	4.363	3.810
3.270	1.583	4.535	4.298
3.471	1.897	5.039	6.039
3.747	2.462		

In NaCl + NaNO₃(aq) at 298.1°K (432)

$C(\text{NaCl})$	$C(\text{NaNO}_3)$	$C(\Sigma\text{Ag} \times 10^3)$
3.743	0.00	2.457
3.592	.84	2.493
3.462	1.50	2.538

In KCl (aq) (432)

$C(\text{KCl})$	$C(\Sigma\text{Ag} \times 10^3)$	$C(\text{KCl})$	$C(\Sigma\text{Ag} \times 10^3)$
$T = 274.1^\circ\text{K}$		$T = 298.1^\circ\text{K}$.—(Cont'd)	
3.325	1.734	2.850	1.845
$T = 298.1^\circ\text{K}$		3.081	2.435
1.111	0.141	3.083	2.415
1.425	.235	3.424	3.602
1.713	.391	3.843	5.725
2.022	.616	$T = 308.1^\circ\text{K}$	
2.396	1.050	2.955	2.786
2.628	1.390		

 $T = 298.1^\circ\text{K}$ (498)

$C(\text{KCl} \times 10^5)$	$C(\Sigma\text{Ag} \times 10^5)$	$C(\text{KCl} \times 10^5)$	$C(\Sigma\text{Ag} \times 10^5)$
3.16	1.28	20.0	2.13
6.32	1.52	40.0	2.24

In KNO₃(aq) (1261)

T	$C(\text{KCl})$	$C(\Sigma\text{Ag} \times 10^5)$
291.1	0.01	1.04
298.1	.01	1.43

AgCl(s) = AgCl(l)

$$\Delta H^0 = 3\,050; \Delta F_{724.1}^0 = 0\, (506); \Delta F_{298.1}^0 = 1\,900\, (161)$$

AgCl.NH₃(s) = AgCl(s) + NH₃(g) (107) (E)

T	P	T	P
273.1	0.022	315.1	0.316
289.4	0.055	316.1	0.332
304.1	0.132*	332.1	0.807
305.9	0.155	336.1	0.859

 $\Delta H = 11\,110$ (94)

* Interpolated.

AgCl.1½NH₃(s) = (mixed crystals of lower NH₃ content) + xNH₃(g) (94, 107) (E)

T	P	T	P
273.1	0.0553	292.1	0.209
278.1	0.0724	299.1	0.304
287.1	0.132*	305.9	0.482
289.6	0.153	$\Delta H = 10\,520\text{x}$	

* Interpolated from (94); all other values from (107). For NH₃ content of somewhat less than 1½ molecules, the pressure-temperature curves show irregularities (decrease of pressure with rise of temperature), on account of mixed crystals of a composition depending upon the temperature (107); cf. (650, 666, 696).

2AgCl.3NH₃(s) + 3H₂O(l) = 2AgCl(s) + 3NH₄OH(aq) (1410) $T = 298.1^\circ\text{K}$

$m(\Sigma\text{NH}_3)$	$m(\Sigma\text{Ag})$	$m(\text{NH}_4\text{OH})$	$K^{1/3}$	μ
6.26	0.745	4.77	4.77	0.745
6.27	.754	4.76	4.76	.754
6.25	.757	4.74	4.74	.757
6.25	.760	4.73	4.73	.760

AgCl.3NH₃(s) = AgCl.1½NH₃(s) + 1½NH₃(g) (94, 107, 384);
cf. (646, 650, 696) (E)

T	P	T	P
248.1	0.0743	282.1*	0.611
253.1*	0.0842	282.6	0.612
257.1	0.111	287.1	0.832
260.1†	0.132†	289.1*	0.875
273.1	0.357	289.4	0.922
273.1*	0.338	290.4*	0.968

 $\Delta H = 13\,740$

* From (384). † Interpolated from (94); all other values from (107).

AgCl.CH₃NH₂(s) = AgCl(s) + CH₃NH₂(g) (696) (E)

T	P	T	P
273.1	0.012	314.1	0.221
282.6	0.025	319.6	0.309
288.1	0.037	324.1	0.411
289.9	0.042	334.1	0.770
293.6	0.057	338.1	0.993
305.1	0.121		

AgClO₃.3NH₃(s) = (?) + xNH₃(g) (384) (E)

T	P	T	P
284.1	0.012	288.6	0.559
319.1	0.428	338.6	1.000 (extrap.)

AgClO₄.3NH₃(s) = (?) + xNH₃(g) (384) (E)

T	P	T	P
282.1	0.042	350.1	0.896
315.1	0.209	351.4	0.945
332.6	0.442	352.1	0.961
344.1	0.704		

AgBr(s)

 $E_{298.1}^0 = 0.9925; \Delta F_{298.1}^0 = -22\,910$ (1189) from (890); cf. (1181)½H₂(g) + AgBr(s) = Ag(s) + H⁺ + Br⁻ (890)Constant = -0.6103; $E_{298.1}^0 = 0.0725; \Delta F_{298.1}^0 = -1\,673$

$m^{1/2}$	$E_{298.1}$	$\log \gamma + \text{const.}$
0.1	0.3141	-0.6551
.1732	.2604	-0.6783
.3162	.2022	-0.7092

Pb(s) + 2AgBr(s) = 2Ag(s) + PbBr₂(s)

$E^0 = 0.3552 - 0.000126t; E_{298.1}^0 = 0.3520$ (amorphous AgBr);
 $E^0 = 0.3550 - 0.000123t; E_{298.1}^0 = 0.3517$ (fused AgBr) (792);
 $E^0 = 0.3592 - 0.000275t; E_{298.1}^0 = 0.3524$ (1173)

Pb (in het. amal.) + 2AgBr(s) = 2Ag(s) + PbBr₂(s) $E = 0.3537 - 0.000289t; E_{298.1} = 0.3465$ (1173)AgBr(s) = Ag⁺ + Br⁻ + (?) complexIn Hg(NO₃)₂ (aq) at 298.1°K (1019)

$C(\text{Hg}(\text{NO}_3)_2)^*$	$C(\Sigma\text{Ag})$	$C(\text{Hg}(\text{NO}_3)_2)^*$	$C(\Sigma\text{Ag})$
0.0100	0.00306	0.05	0.00639
.0125	.00329	.1	.00873
.025	.00459	1.0	.03660

* HNO₃ present in these solutions.

In KBr (aq) at 298.1°K (597)

$C(\text{KBr})$	$C(\Sigma\text{Ag})$	$C(\text{KBr})$	$C(\Sigma\text{Ag})$
2.76	0.0117	4.44	0.0955
3.68	.0400	4.864	.1407
4.18	.0718		

AgCl(s) + Br⁻ = AgBr(s) + Cl⁻ $E_{298.1}^0 = 0.150; \Delta F_{298.1}^0 = -3\,461$ (1181) from (505)

$\text{AgBr} \cdot \text{NH}_3(\text{s}) = \text{AgBr}(\text{s}) + \text{NH}_3(\text{g})$ (107, 707) (E)
 $\Delta H = 10\,650$ (94); $\log P = -4\,033/T - 13.249 \log T + 44.7039$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.039	310.6	0.479
278.1	0.067	316.1	0.726
305.6	0.367	324.6*	1.000

* From (707); all other values from (107).

$\text{AgBr} \cdot 1\frac{1}{2}\text{NH}_3(\text{s}) = (\text{Unsaturated mixed crystals with } \text{AgBr} \cdot \text{NH}_3) + x\text{NH}_3(\text{g})$ (696, 707) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.116	289.7	0.328
277.1	0.141	301.7	0.675
283.5	0.218	307.1*	1.000
284.3	0.229	316.9	1.612
287.1	0.271	326.1	2.613

* From (707); all other values from (696).

$\Delta H = 9\,950x$ (94); $\log P = -6650.6/T - 34.239 \log T + 108.3096$ (707); according to (107), the decomposition of the mixed crystals gives:

Moles NH_3	<i>T</i>	<i>P</i>
1.32	278.1	0.149
1.22	305.6	0.538
1.23	315.7	0.921

$\text{AgBr} \cdot 3\text{NH}_3(\text{s}) = \text{AgBr} \cdot 1\frac{1}{2}\text{NH}_3(\text{s}) + 1\frac{1}{2}\text{NH}_3(\text{g})$ (E)
 $P_{276.6} = 1.00$; $\log P = -1787.13/T + 1.075 \log T + 2.8340$ (707);
 $\Delta H = 12\,960$ (94); cf. (696)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.014	318.3	0.382
292.6	0.068	328.1	0.676
93.6	0.076		

$\text{AgBrO}_3(\text{s}) = \text{Ag}^+ + \text{BrO}_3^-$ (626)

$\Delta F_{298.1}^0 = 5847$; $K = 5.20 \times 10^{-5}$

$\text{AgBrO}_3 \cdot 3\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (384) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
252.1	0.276	274.1	1.000
267.1	0.662	274.6	1.053
273.1	0.947		

$\text{AgI}(\text{l}) = \text{Ag}(\text{s}) + \frac{1}{2}\text{I}_2(\text{g})$ (1045)

$\text{AgI}(\text{s})$

$E_{298.1}^0 = 0.6856$; $\Delta F_{298.1}^0 = -15\,820$ in 0.1*N* KI (470); cf. (730, 731, 1119)

$\text{Ag}(\text{s}) + \frac{1}{2}\text{I}_2(\text{s}) = \text{AgI}(\text{s})$

$E^0 = A + Bt$

A	B	$E_{298.1}^0$	Remarks	Lit.
		0.6831	0.5 <i>N</i> KI	(424)
		0.6812	0.333 <i>N</i> KI	(424)
0.6818	0.000152	0.6856	0.1 <i>N</i> KI	(470)
($E_{273.1}^0 = 0.6834$)		0.6872	1 <i>N</i> KI	(470)
		0.6842	0.5 <i>N</i> KI	(476)
		0.6821	0.025 <i>N</i> KI	(476)
($E_{273.1}^0 = 0.6812$)		0.6858	0.1 <i>N</i>	(729, 1189)
($E_{273.1}^0 = 0.6798$)		0.6850	0.05 <i>N</i>	(729, 1189)
0.6823	0.000160	0.6863	0.1 <i>N</i>	(729, 730)
0.67974	0.000217	0.68516	0.05 <i>N</i>	(730)
0.67961	0.000206	0.68475	0.02 <i>N</i>	(730)
0.67927	0.000209	0.68462	0.01 <i>N</i>	(730)
0.68253	0.000084	0.68463	0.33 <i>N</i> (ca.)	(730)
		0.6857		(1119)

$\text{Pb}(\text{s}) + 2\text{AgI}(\text{s}) = 2\text{Ag}(\text{s}) + \text{PbI}_2(\text{s})$

$E^0 = A - Bt$

A	B	$E_{298.1}^0$	Remarks	Lit.
0.2183	0.000177	0.2139	0.1 <i>N</i> KI (AgI, amorph.)	(470)
0.2167	0.000178	0.2123	1 <i>N</i> KI (AgI, amorph.)	(470)
0.2146	0.000130	0.2114	AgI, amorph.	(792)
0.2145	0.000137	0.2111	AgI, fused	(792)

Pb (in het. amalg.) + $2\text{AgI}(\text{s}) = 2\text{Ag}(\text{s}) + \text{PbI}_2(\text{s})$
 $E = 0.2128 - 0.000191t$; $E_{298.1} = 0.2080$, 0.1*N* KI; $E = 0.2112 - 0.000192t$; $E_{298.1} = 0.2064$, *N* KI (470)

Pb (amalg., $x_2 = 0.00697$) + $2\text{AgI}(\text{s}) = \text{PbI}_2 + 2\text{Ag}(\text{s})$

$E_{273.1}$	$E_{298.1}$	Remarks	Lit.
0.20965	0.20065	0.05 <i>N</i> KI	(1426)
0.20905	0.19977	0.1 <i>N</i> KI	(1426)
0.20405	0.19625		(1429)

Cd (in het. amalg.) + $2\text{AgI}(\text{s}) = 2\text{Ag}(\text{s}) + \text{CdI}_2(\text{s})$

$E_{273.1} = 0.3006$; $E_{298.1} = 0.3035$; $E_{313.1} = 0.3050$ (1429)

$\text{AgI}(\text{s}) = \text{Ag}^+ + \text{I}^- + (?)$ complex

In $\text{Hg}(\text{NO}_3)_2(\text{aq})$ at 298.1°K (1019)

$C(\text{Hg}(\text{NO}_3)_2)^*$	$C(\Sigma\text{Ag})$	$C(\text{Hg}(\text{NO}_3)_2)^*$	$C(\Sigma\text{Ag})$
0.0100	0.00340	0.050	0.00740
.0125	.00358	.10	.01161
.025	.00476	1.0	.10700

* Solutions contain HNO_3 .

In $\text{AgNO}_3(\text{aq})$ at 298.1°K (597)

$C(\text{AgNO}_3)$	$C(\Sigma\text{I})$	$C(\text{AgNO}_3)$	$C(\Sigma\text{I})$
0.20	0.000289	0.50	0.00127
.35	.000532	.75*	.00362

* In more concentrated solutions there is a complex solid phase.

$\text{AgI}(\text{s}) = \text{AgI}$ (hexag.)

$\Delta F_{298.1}^0 = -531$ (1181)

$\text{AgI} \cdot \frac{1}{2}\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (696, 707) (E)

$\log P = -3438.36/T - 8.88031 \log T + 31.1991$ (707)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.004	338.1	0.355
292.1	0.016	353.1	0.638
310.1	0.068	363.1*	1.000
312.1	0.083	373.1	1.506
325.6	0.204		$\Delta H = 11\,590x$ (94)

* From (707); all other values from (696).

$\text{AgI} \cdot \text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (94, 107, 696, 707) (E)

$\log P = -1787.1294/T + 1.0741 \log T + 2.8340$ (707)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
241.1*	0.0789	276.6†	0.921
246.1†	0.132	279.3	1.079
250.1	0.191	283.6	1.388
260.1	0.368	288.1	1.816
273.1	0.770	293.6	2.658
273.1†	0.812		$\Delta H = 8\,650x$ †

* From (107). † From (94). ‡ From (707); all other values from (696).

$\text{AgI} \cdot 1\frac{1}{2}\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (94, 107) (E)

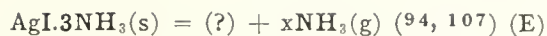
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
215.8	0.102	241.5	0.475
223.1*	0.132	253.1	0.912
231.6	0.204		$\Delta H = 7\,250x$ *

* From (94); value at 223.1°K interpolated; all other values from (107).

$\text{AgI} \cdot 2\text{NH}_3(\text{s}) = (?) + x\text{NH}_3(\text{g})$ (94, 107) (E)

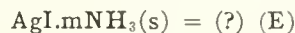
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
194.1	0.022	216.1*	0.132 (extrap.)
215.8	0.136		$\Delta H = 7\,050$ *

* From (94); all other values from (107).

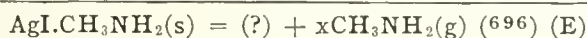


T	P	T	P
194.1	0.042	231.6	0.467
212.1*	0.132	241.5	0.833
215.8	0.162	$\Delta H = 6\,920\text{x}^*$	

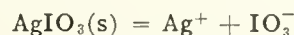
* From (94); value at 212.1°K extrapolated; all other values from (107).



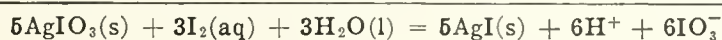
The decomposition of all compounds results in formation of mixed crystals (107)



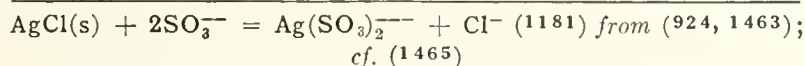
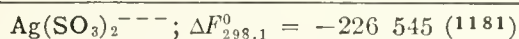
T	P	T	P
273.1	0.046	313.1	1.056
288.1	0.187	318.1	1.487
298.6	0.395	320.1	1.592
302.6	0.530	324.1	1.789
307.1	0.724	329.1	2.072
311.1	0.938	333.1	2.296



$$K_{298.1} = 5.29 \times 10^{-8}; \Delta F_{298.1}^0 = 10\,270 \text{ (1084)}$$

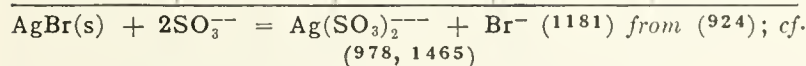


$$\Delta F_{298.1}^0 = 4\,190 \text{ (885) from (1291)}$$



$$K_{298.1} = 0.0578; \Delta F_{298.1}^0 = 1\,690$$

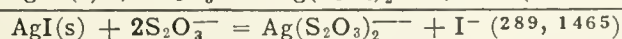
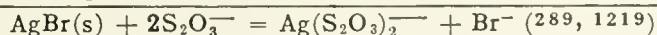
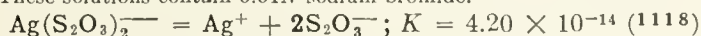
Total $c(\text{SO}_3)$	$c(\text{AgCl})$	$c(\text{SO}_3^{--}, \text{free})$	$\log K_c + 2$	$\mu_c^{1/2}$
0.937	0.142	0.653	0.672	1.72
.890	.140	.610	.724	1.68
.652	.103	.446	.633	1.44
.470	.070	.330	.653	1.22
.470	.070	.330	.653	1.22
.472	.070	.332	.653	1.22
.234	.036	.162	.763	0.859
.220	.033	.154	.672	.832
.219	.034	.151	.708	.831
.106	.017	.066	.756	.579
.080	.011	.058	.591	.501
.079	.012	.055	.602	.499
.478	.057	.364	.663	1.24
.483	.059	.365	.681	1.26



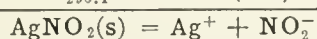
$$K_{298.1} = 1.76 \times 10^{-4}; \Delta F_{298.1}^0 = 5\,124$$

Total $c(\text{SO}_3)$	$c(\text{AgBr})$	$c(\text{SO}_3^{--}, \text{free})$	$\log K_c + 4$	$\mu_c^{1/2}$
0.675	0.0084	0.658	0.204	1.426
.474	.0055	.463	.146	1.19
.466	.0053	.453	.146	1.18
.232	.0025	.227	.079	0.831
.406*	.0023	.401	.230	1.11
.448*	.0023	.443	.146	1.16

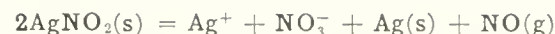
* These solutions contain 0.01N sodium bromide.



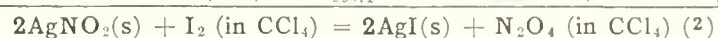
$$\Delta F_{298.1}^0 = 4\,900 \text{ (885)}$$



$$\Delta F_{298.1}^0 = 5\,050 \text{ (885); } K_{298.1} = 2.0 \times 10^{-4} \text{ (6) from (5, 892, 1049, 1050)}$$

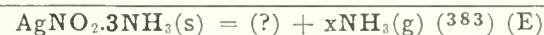


$$\Delta F_{298.1}^0 = 3\,600 \text{ (885) from (6); } P_{(\text{NO})} = 4.28 \text{ atm.; } m_{(\text{AgNO}_3)} = 0.179 \text{ at } 328.1^\circ\text{K (885) from (6). } P_{(\text{NO})} = 8.35 \text{ atm.; } m_{(\text{AgNO}_3)} = 1.10 \text{ at } 373.1^\circ\text{K (860). } \Delta F_{298.1}^0 = 2\,680 + 200 \text{ (1193, 1194)}$$

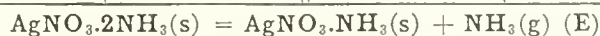


T	$c_{(\text{I}_2)}^*$	$c_{(\text{N}_2\text{O}_4)}$
298.1	0.0397	3.96

* I_2 is 0.35 saturated.



T	P	T	P
253.1	0.018	319.1	0.388
273.1	0.041	330.1	0.603
291.1	0.102	338.6	0.855
309.1	0.251	341.1	0.942

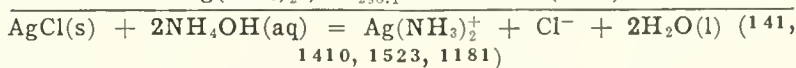
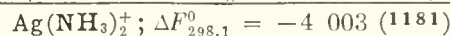


$P_{443.1} = 1.0$; the dissociation curves proceed irregularly (707)



$$\log P = -5\,864.68/T - 26.1384 \log T + 82.4857 \text{ (707)}$$

T	P	T	P
273.1	0.037	313.6	0.374
283.1	0.071	323.6	0.595
293.1	0.132	331.6	0.845
304.1	0.236	336.1	1.016



$$K_{298.1} = 2.86 \times 10^{-3}; \log p.f._{298.1} = 1.272; \Delta F_{298.1}^0 = 3472 \text{ (1181)}$$

Total $m(\text{NH}_3)$	$m(\text{Ag}^+)$	$m(\text{NH}_4\text{OH}, \text{free})$	$m(\text{NaCl})$	$\log (1/K_m^{1/2})$	$\mu^{1/2}$	Lit.
0.0942	0.004592	0.0838		1.261	0.0764	(141)
.1006	.005164	.0890		1.236	.0804	(141)
.1033	.005343	.0912		1.232	.0820	(141)
.1089	.005665	.0960		1.229	.0835	(1181)
.2084	.01137	.1837		1.208	.1156	(141)
.2947	.01588	.2605		1.215	.1355	(141)
.437	.023	.388		1.227	.161	(1410)
.428	.025	.375		1.176	.167	(1410)
.4881	.02588	.4333		1.204	.169	(141)
.7522	.04758	.6532		1.138	.227	(141)
.7517	.04173	.6440	0.0102*	1.141	.236	(141)
.7477	.04392	.6561	.0102	1.129	.241	(141)
.7503	.03503	.6255	.0256*	1.133	.253	(141)
.9662	.06117	.8394		1.138	.256	(141)
.7458	.03869	.6641	.0255	1.125	.261	(141)
.7550	.02751	.5933	.0513*	1.106	.282	(141)
.7497	.03330	.6788	.0511	1.108	.297	(141)
1.3039	.0895	1.1198		1.097	.307	(1181)
1.700	.1197	1.4545		1.085	.355	(1410)
1.710	.1256	1.4525		1.063	.363	(1181)
1.688	.1308	1.419		1.035	.370	(1410)
1.9044	.13616	1.6252		1.077	.378	(141)
1.8782	.1379	1.5956		1.064	.380	(1181)
2.1339	.1628	1.8009		1.054	.413	(1181)
2.6400	.2151	2.2014		1.010	.473	(1181)
2.8393	.2254	2.3796		1.024	.484	(141)
2.9091	.2395	2.4211		1.005	.498	(1181)
3.7574	.3438	3.0596		0.949	.595	(141)
3.782	.372	3.028		.911	.618	(1410)
3.945	.378	3.171		.924	.624	(1410)
4.6918	.4680	3.7443		.903	.693	(141)
5.10	.574	3.938		.836	.760	(1410)
5.33	.609	4.098		.828	.788	(1410)
5.545	.633	4.265		.829	.803	(1410)

* Added salt, AgNO_3 .

AgCl(s) + 2NH₄OH(aq).—(Continued)
(1523); cf. (464, 696, 906, 1148, 1465)

Total $c_{\text{(NH}_3\text{)}}$	$c_{\text{(AgCl)}}$	$c_{\text{(NH}_4\text{OH)}}$	log ($1/K_c^{\mu_{1/2}}$)	$\mu_{1/2}$
0.0282	0.00141	0.02481	1.245	0.0445
.0285	.00142	.02509	1.247	.0446
.0287	.00143	.02527	1.247	.0447
.0288	.00149	.02525	1.229	.0454
.0585	.00300	.0514	1.224	.0638
.0589	.00297	.0519	1.225	.0636
.0590	.00304	.0518	1.231	.0641
.118	.00625	.1040	1.221	.0881
.118	.00619	.1041	1.226	.0878
.118	.00621	.1041	1.224	.0879
.252	.0139	.2218	1.203	.1271
.252	.0140	.2218	1.200	.1275
.253	.0140	.223	1.202	.1275
.397	.0227	.349	1.191	.1582
.411	.0235	.361	1.186	.163
.416	.0240	.365	1.182	.164
.428	.0249	.375	1.178	.167
.818	.0514	.711	1.141	.236
.863	.0541	.751	1.142	.242
.873	.0555	.758	1.135	.245
.896	.0569	.777	1.135	.248
.903	.0572	.784	1.137	.249
.909	.0584	.788	1.130	.251
.916	.0583	.794	1.134	.251
.961	.0616	.833	1.131	.258
1.991	.147	1.690	1.061	.392
2.013	.149	1.708	1.060	.395
2.017	.149	1.712	1.061	.395
2.042	.151	1.733	1.060	.398

AgBr(s) + 2NH₄OH(aq) = Ag(NH₃)₂⁺ + Br⁻ + H₂O(l) (1181)
from (141, 1523)

Total $c_{\text{(NH}_3\text{)}}$ (1523)	$c_{\text{(AgBr)}}$	$c_{\text{(NH}_4\text{OH, free)}}$	log ($1/K_c^{\mu_{1/2}}$)	$\mu_{1/2}$
0.0777	0.000264	0.0760	2.469	0.0384
.0764	.000276	.0747	2.433	.0384
.118	.000386	.1115	2.476	.0436
.115	.000391	.1125	2.459	.0435
.273	.001070	.269	2.400	.0586
.268	.000941	.264	2.448	.0573
.497	.001590	.491	2.490	.0694
.450	.001700	.445	2.418	.0691

Total $m_{\text{(NH}_3\text{)}}$ (141)	$m_{\text{(AgBr)}}$	$m_{\text{(NH}_4\text{OH, free)}}$	log ($1/K_m^{\mu_{1/2}}$)	$\mu_{1/2}$
0.1932	0.00060	0.1901	2.501	0.0504
.3849	.00120	.3797	2.500	.0630
.5741	.00179	.5682	2.502	.0724
.7573	.00223	.7488	2.526	.0789
1.965	.00692	1.944	2.449	.1166
3.024	.01163	2.992	2.410	.1257
5.244	.02443	5.181	2.326	.1894

log $p.f.$ _{298.1} = 2.537; $K_{298.1}$ = 8.4×10^{-4} ; $\Delta F_{298.1}^0$ = 6 934;
(1181); cf. (696, 906, 1148)

AgI(s) + 2NH₄OH(aq) = Ag(NH₃)₂⁺ + I⁻ + 2H₂O(l) (61, 62,
807, 906)

Ag(NH₃)₂Cl(aq) (1181)

m	log γ	(log γ)/ $\mu_{1/2}$
0.001	-0.017	-0.530
.002	-0.024	-0.535
.005	-0.040	-0.566
.01	-0.056	-0.560
.02	-0.080	-0.566
.05	-0.126	-0.563
.1	-0.176	-0.556
.2	-0.248	-0.554
.5	-0.382	-0.540

2AgP₂(s) = 2Ag(s) + P₄(g) (507)

T	P	T	P
663.1	0.0771	793.1	0.2275
673.1	.0776	878.1	.2816
723.1	.1436	883.1	.2822

AgHCO₃(s) = Ag⁺ + HCO₃⁻

$K_{291.1} = 1.23 \times 10^{-4}$; $\Delta F_{291.1}^0 = 5\ 210$ (1191) from (564)

AgCN(s); $\Delta F_{298.1}^0 = 38\ 499$ (1181)

AgCN.NH₃(s) = AgCN(s) + NH₃(g) (E)

$P_{373.1} = 0.091$; log $P = -12\ 497.12/T - 58.7176 \log T + 183.4738$
(707)

AgCl(s) + CNS⁻ = AgCNS(s) + Cl⁻ (1181) from (624)

$K_{298.1} = 161$; $\Delta F_{298.1}^0 = -3\ 012$

$c_{\text{(Cl}^-)}$	$c_{\text{(CNS}^-)}$	log K_c	$\mu_c^{\mu_{1/2}}$
0.197	0.00104	2.278	0.450
.193	.00100	2.286	.450
.0501	.00293	2.232	.224
.0489	.00280	2.242	.224
.010	.00060	2.222	.10
.010	.00057	2.244	.10

AgBr(s) + CNS⁻ = AgCNS(s) + Br⁻ (1181) from (624)

$K_{298.1} = 0.505$; $\Delta F_{298.1}^0 = 404$

$c_{\text{(Br}^-)}$	$c_{\text{(CNS}^-)}$	log K_c	$\mu_c^{\mu_{1/2}}$
0.0647	0.1205	0.270	0.447
.0665	.1207	.258	.447
.0165	.0312	.276	.224
.0176	.0324	.265	.224

AgC₂H₃O₂(s) (Acetate) + H⁺ = Ag⁺ + C₂H₄O₂

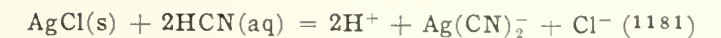
In HNO₃(aq) at 298.1°K (629, 630)

$c_{\text{(ΣH}^+)}$	$c_{\text{(Ag}^+)}$	d_{25}^{25}
0.0	0.0667	1.005
.4845	.511	1.072
.9506	.970	1.140
1.789	1.841	1.267
3.269	3.290	1.470
3.923	3.929	1.561
4.703	4.745	1.670

Ag(CN)₂⁻; $\Delta F_{298.1}^0 = 72\ 047$ (1181)

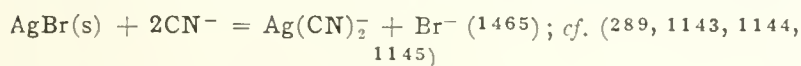
AgCl(s) + 2CN⁻ = Ag(CN)₂⁻ + Cl⁻ (1465); cf. (1143, 1144, 1145)
 $T = 298.1^\circ\text{K}$

$m_{\text{(Cl}^-)}$	$m_{\text{(Ag(CN)}_2^-)}$	$m_{\text{(CN}^-)}$	K
0.192	0.192	0.384	0.25



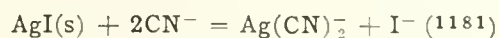
$$K_{298.1} = 1.9 \times 10^{-9}; \log p.f._{298.1} = 2.180; \Delta F_{298.1}^0 = 11\,902$$

$m_{\text{HCN(aq)}}$	m_{acid}	m_{complex}	m_{chloride}	$\log (1/K_m^{1/2})$	$\mu^{1/2}$
0.0938	0.00303	0.00132	0.00161	2.163	0.0552
.1831	.00430	.00182	.00258	2.146	.0652
.2292	.00493	.00199	.00294	2.141	.0702



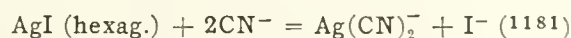
$$T = 298.1^\circ\text{K}$$

m_{Br^-}	$m_{\text{Ag(CN)}_2^-}$	m_{CN^-}	K
0.349	0.349	0.070	24.8



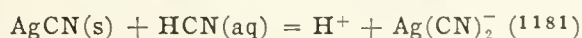
$$K_{298.1} = 221; \Delta F_{298.1}^0 = -3\,201$$

Total m_{CN^-}	m_{AgI}	m_{CN^-} , free	m_{NaOH} , added	$\log K_m^{1/2}$	$\mu^{1/2}$
0.01837	0.00866	0.00065	0.0197	1.131	0.192
.03676	.01778	.00120	.0200	1.170	.238
.05521	.02666	.00191	.0199	1.146	.275
.07337	.03549	.00239	.0196	1.173	.305



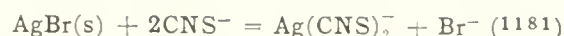
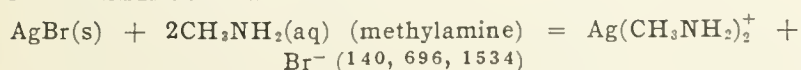
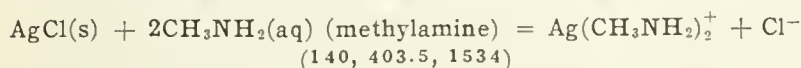
$$K_{298.1} = 90.4; \Delta F_{298.1}^0 = -2\,670$$

Total m_{CN^-}	m_{AgI}	m_{CN^-} , free	m_{NaOH} , added	$\log (K_m^{1/2})$	$\mu^{1/2}$
0.0208	0.0102	0.00049	0.0244	1.301	0.212
.0208	.0093	.0021	.0244	0.653	.212
.0405	.0191	.00224	.0444	.931	.292
.0836	.0386	.00456	.0946	.938	.423
.0836	.0396	.00434	.0946	.961	.423
.146	.0684	.00889	.1738	.886	.566
.195	.0911	.0126	.2433	.858	.663
.195	.0916	.0116	.2433	.897	.663
.261	.1217	.0177	.2448	.836	.712
.318	.1474	.0232	.2421	.802	.748
.318	.1475	.0230	.2421	.806	.748
.398	.1840	.0300	.2424	.788	.800

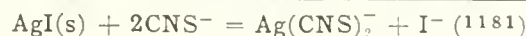


$$K_{298.1} = 3.77 \times 10^{-5}; \log p.f._{298.1} = 2.212; \Delta F_{298.1}^0 = 6\,038$$

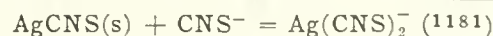
$m_{\text{HCN(aq)}}$	$m_{\text{HAg(CN)}_2}$	$\log (1/K_m^{1/2})$	$\mu^{1/2}$
0.0296	0.000983	2.244	0.0314
.1016	.002039	2.144	.0452
.1596	.00245	2.211	.0496
.1780	.00366	2.067	.0606
.1825	.00246	2.198	.0544
.2124	.00292	2.197	.0541
.2245	.00272	2.241	.0523
.2275	.00424	2.050	.0652
.2325	.00316	2.184	.0562
.3000	.00375	2.164	.0612
.3625	.00331	2.254	.0576
.4230	.00400	2.210	.0653
.4260	.00511	2.106	.0612
.4465	.00427	2.195	.0654



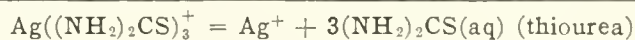
Total m_{KCNs}	m_{AgBr}	$m_{\text{KCNs, free}}$	$\log (K_m^{1/2})$
0.2510	0.0011	0.249	-2.340
.2702	.0012	.267	-2.340
.5205	.0095	.501	-1.722
.5819	.0085	.564	-1.824
.7577	.0285	.701	-1.390
.7762	.0307	.715	-1.367
1.0089	.0663	.875	-1.122
1.0089	.0668	.875	-1.118



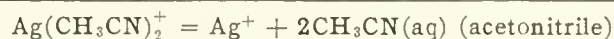
Total m_{KCNs}	$m_{\text{AgI}} \times 10^4$	$m_{\text{KCNs, free}}$	$\log (K_m^{1/2})$
0.202	0.20	0.202	-4.00
.315	.14	.315	-4.30
.425	.67	.425	-3.91
.500	.51	.500	-4.00
.608	.40	.608	-4.18
.710	.97	.710	-3.85
.765	1.46	.765	-3.72
1.009	1.63	1.008	-3.80



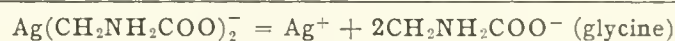
Original m_{KCNs}	m_{AgCNS}	$m_{\text{KCNs, free}}$	$\log (K_m)$
0.312	0.00202	0.310	-2.187
.564	.0121	.512	-1.627
.870	.0458	.824	-1.255
1.124	.0985	1.026	-1.018



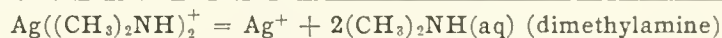
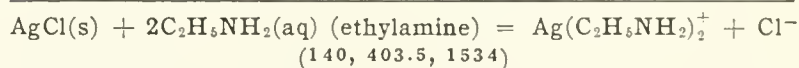
$$K = 1.39 \times 10^{-14} \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



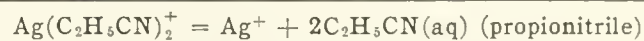
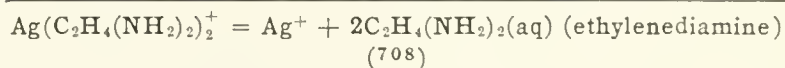
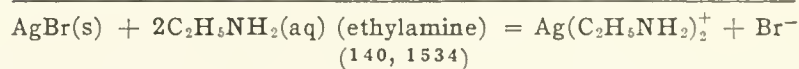
$$K = 5.93 \times 10^{-2} \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



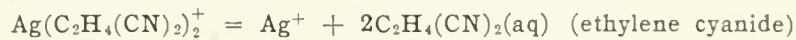
$$K = 1.10 \times 10^{-5} \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



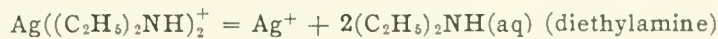
$$K = 2.53 \times 10^{-6} \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



$$K = 0.114 \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



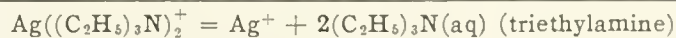
$$K = 0.1 \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



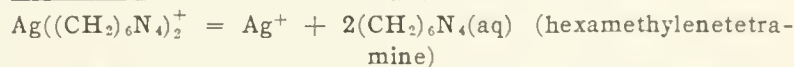
$$K = 1.71 \times 10^{-6} \text{ at } T = 293^\circ\text{K} (?) \quad (1118); \text{cf. (709)}$$



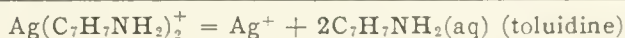
$$K = 5.85 \times 10^{-4} \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



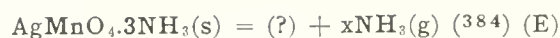
$$K = 8.85 \times 10^{-5} \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



$$K = 2.65 \times 10^{-4} \text{ at } T = 293^\circ\text{K} (?) \quad (1118); \text{cf. (709)}$$

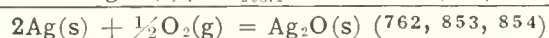
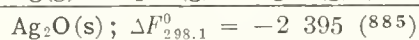
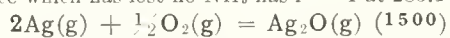


$$K = 2.46 \times 10^{-4} \text{ at } T = 293^\circ\text{K} (?) \quad (1118)$$



T	P	T	P
252.1	0.127	283.1	0.882
273.1	0.434	285.1*	0.934
282.1	0.812		

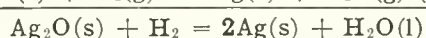
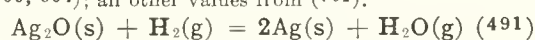
* The substance which has lost no NH_3 has $P = 1$ at 285.1°K .



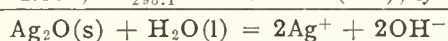
$$\Delta F^0 = -7 \ 240 - 1.0T \ln T + 21.95T; \Delta H_{298.1}^0 = -6 \ 942; \Delta F_{298.1}^0 = -2 \ 395 \quad (885); \text{cf. } (756, 1428)$$

T	P	T	P
575.1*	20.5	725.1	213.5
598.1*	32.0	740.8	257.8
647.1	74.3	757.1	323.5
676.1	114.5	773.3	388.3
718.1*	207		

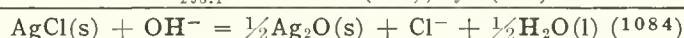
* From (853, 854); all other values from (762).



$$E_{298.1}^0 = 1.582; \Delta F_{298.1}^0 = -53 \ 449 \quad (218); \text{cf. } (4, 925)$$

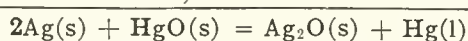


$$\Delta F_{298.1}^0 = 10 \ 520 \quad (159); \text{cf. } (701)$$

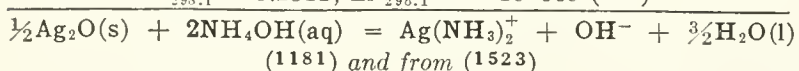


$c(\text{KOH})$	$c(\text{KCl})$	μ_c	K_c
$T = 298.1^\circ\text{K}$			
0.0542	0.000494	0.0547	0.00902
0.0597	0.000530	0.0602	0.00877
0.0650	0.000620	0.0656	0.00941
0.0707	0.000666	0.0714	0.00928
0.0944	0.000918	0.0953	0.00948
0.1095	0.001046	0.1111	0.00927
0.3297	0.003295	0.3330	0.00999
0.3349	0.003303	0.3382	0.00986
0.3495	0.003410	0.3529	0.00976
0.3568	0.003503	0.3603	0.00982
0.3578	0.003434	0.3612	0.00960
0.3583	0.003540	0.3618	0.00988

In dilute soln., $a_{(\text{H}_2\text{O}(\text{l}))} = 1 \quad (1084)$; $K_{298.1} = 0.00891$; $\Delta F_{298.1}^0 = 2 \ 798 \quad (877, 878, 879, 885)$



$$E_{298.1}^0 = 0.2312; \Delta F_{298.1}^0 = -10 \ 669 \quad (218)$$

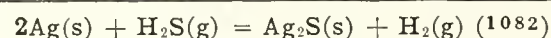


$$\log p.f._{298.1} = 0.247; \log K_{298.1} = -0.494 \pm 0.005; \Delta F_{298.1}^0 = 674 \quad (1181)$$

m (total base)	$m_{(\text{Ag}^+)} (\text{NH}_3)^+$	$m_{(\text{NH}_4\text{OH})}$	$1/K_m^{1/2}$	$1/K_m^{1/2}$	$\log (1/K_m^{1/2})$	$\mu^{1/2}$
0.05302	0.01155	0.01838	1.59	1.59	0.201	0.107
.05532	.01282	.01667	1.32	1.32	.119	.113
.05821	.01338	.01806	1.35	1.36	.133	.116
.06173	.01406	.01955	1.39	1.40	.146	.119
.1479	.03499	.04289	1.23	1.25	.097	.187
.1575	.03606	.04932	1.37	1.39	.143	.190
.2456	.05787	.07198	1.25	1.26	.100	.240
.3155	.07352	.09490	1.29	1.32	.120	.272
.3200	.07535	.09494	1.26	1.29	.111	.274
.3540	.07787	.1231	1.55	1.59	.201	.279
.6519	.1525	.1945	1.28	1.34	.127	.391
.6767	.1582	.2021	1.28	1.34	.127	.398
.6950	.1623	.2082	1.28	1.35	.130	.403
.8673	.2033	.2574	1.26	1.34	.127	.452
.9518	.2225	.2841	1.26	1.35	.130	.472
1.2304	.2888	.3642	1.26	1.38	.140	.538

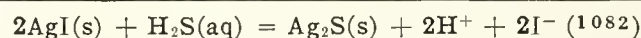


Total $c(\text{NH}_3)$	μ_c	$c(\text{NH}_4\text{OH})$	$1/K_c^{1/2}$	$(1/K_c^{1/2})$	$\log (1/K_c^{1/2})$	$\mu_c^{1/2}$
0.214	0.0654	0.0832	1.272	1.300	0.114	0.256
.220	.0658	.0884	1.343	1.373	.137	.257
.458	.134	.190	1.417	1.467	.165	.366
.469	.140	.189	1.350	1.412	.150	.374
.671	.205	.261	1.275	1.355	.132	.453
.684	.205	.274	1.337	1.423	.153	.453
.720	.225	.270	1.200	1.288	.110	.474
.733	.224	.285	1.273	1.378	.139	.474
.830	.242	.346	1.430	1.543	.188	.492
.827	.248	.331	1.336	1.446	.159	.498
.811	.251	.309	1.232	1.334	.125	.501
.876	.257	.362	1.408	1.528	.184	.508
.915	.276	.363	1.317	1.435	.156	.526
.899	.278	.343	1.234	1.347	.129	.528
.999	.299	.401	1.340	1.472	.168	.548
1.147	.343	.461	1.344	1.498	.173	.585
1.498	.454	.590	1.298	1.452	.162	.674
1.522	.470	.582	1.238	1.393	.144	.686

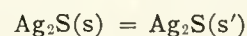


$$\Delta F_{298.1}^0 = -1 \ 688$$

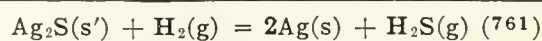
T	$E(0.1\text{HCl})$	$E(0.5\text{HCl})$	E (mean)
278.1	0.0382	0.0379	0.03805
283.1	.0378	.0376	.0377
298.1	.0367	.0365	.0366
308.1	.0358	.0357	.0357



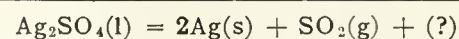
$m_{(\text{H}_2\text{S}, \text{aq})}$	$m_{(\text{HI})}$	$\frac{1}{4} \log (1/K_m)$	$\mu^{1/2}$
0.0002531	0.02435	0.7143	0.1560
.0002954	.02589	.7045	.1609
.0003436	.02664	.7085	.1633
.001006	.03492	.7076	.1869
.002820	.04546	.7050	.2132
.004077	.05047	.6996	.2246
.005053	.05277	.7035	.2297
.006834	.05705	.7025	.2388
.01982	.07491	.6998	.2737
.03318	.08557	.6979	.2925
.03369	.08602	.6973	.2933
.06371	.1015	.6538	.3186
.07747	.1068	.6937	.3268
.1116	.1170	.6937	.34205



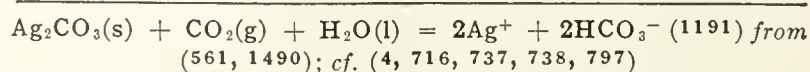
$$\Delta H^0 = 953; \Delta F_{298.1}^0 = 239; \Delta F_{398.1}^0 = 0 \text{ from } (76); \Delta F_{448.1}^0 = 0 \quad (452); \text{cf. } (161, 1323, 1463)$$



T	K	T	K
749.15	0.359	889.63	0.278
811.25	.325		$\Delta F^0 = -2 \ 408 + 5.253T$



$$P_{1358.1} = 1.00 \quad (455); \text{cf. } (636, 949, 950)$$



$$\log p.f._{298.1} = 2.111; \Delta H = -16 \ 990; \Delta F_{298.1}^0 = 11 \ 525$$

T	$m_{(\text{Ag}^+)}$	$p(\text{CO}_2)$	$f(\text{CO}_2)$	$\mu^{1/2}$	$\log (1/K_m^{1/4})$
291.1*	0.00764	1.0	0.99	0.087	2.1158
298.1	.008338	0.943	.934	.0913	2.0716
298.1	.008353	.943	.934	.0914	2.0711
298.1	.008375	.946	.937	.0915	2.0700

Ag₂CO₃(s) + CO₂(g) + H₂O(l).—(Continued)

<i>T</i>	<i>m</i> (Ag ⁺)	<i>P</i> (CO ₂)	<i>f</i> (CO ₂)	<i>μ</i> ^{1/2}	log (1/ <i>K_m</i> ^{1/4})
298.1	0.008437	0.975	0.966	0.0920	2.0700
291.1*	.01234	56	43.46	.111	2.3182

* From (561); all other values from (1490).

Ag₂CO₃(s) = Ag₂O(s) + CO₂(g) (273, 305); cf. (716, 737, 738, 1257)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
405.1	0.0276	483.1	0.736
440.1	.148	491.1	1.004
455.6	.241	492.1*	1.000

* From (273); all other values from (305).

3(AgClO₄)₂ (in C₆H₆, benzene) = 2(AgClO₄)₃ (in C₆H₆) (627)Ag₂S·AgNO₃(s) = 3Ag⁺ + S²⁻ + NO₃⁻In AgNO₃(aq) at 288.1°K* (917)

<i>m</i> (AgNO ₃)	<i>m</i> (Ag ₂ S)	<i>m</i> (AgNO ₃)	<i>m</i> (Ag ₂ S)
2.35	0	5.89	0.000916
2.94	tr.	11.8	.00562
3.92	0.000261		

* For data at 373.1°K, v. (917).

Au, Gold

Au(s); Δ*H*⁰, Δ*F*⁰ = 0Au(OH)₃ = Au⁺⁺⁺ + 3OH⁻*K* = 5.5 × 10⁻⁴⁶ (704)Au(OH)₃(s) + 3H⁺ = Au⁺⁺⁺ + 3/2 H₂O(l)In H₂SO₄(aq) (703)

<i>T</i>	<i>c</i> (H ₂ SO ₄)	<i>c</i> (ΣAu)
291.1	0.265	0.000016
	.445	.000036
	.505	.000042
	.73	.000081
	.79	.00011
292.1	9.35	.0632

In HNO₃(aq) at 295.1°K (704)

<i>c</i> (HNO ₃)	<i>c</i> (ΣAu)
0.45	0.00003

2AuCl(s) = 2Au(s) + Cl₂(g) (989)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
443.1	0.018	489.1	0.118
460.1	.030	513.1	.289
474.1	.065		

AuCl₂NH₃(s) = (?) + xNH₃(g) (386) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
381.6	0.789	387.6	1.053
386.6	1.000		

AuCl₃(s) = AuCl(s) + Cl₂(g); cf. (1258)log *P* = -6937/*T* - 1.177 log *T* + 45.823 (1127); cf. (989)

<i>T</i>	<i>P</i> (total)	<i>P</i> (Cl ₂ (g))	Lit.
373.1		0.0076	(1135)
411.6		.0099	
413.1	0.0054		(1127)
423.1	.0092		
433.1	.0131		
443.1	.0237		
453.1	.0403		
454.1		.0678	(1135)
463.1	.0872		(1127)
473.1	.263		
475.1		.1388	(1135)
483.1	.199		(1127)
493.1	.303		

AuCl₃(s).—(Continued)

<i>T</i>	<i>P</i> (total)	<i>P</i> (Cl ₂ (g))	Lit.
502.1		0.1868	(1135)
503.1	0.438		(1127)
513.1	.629		
523.1	.886		
524.1		1.031	(1135)
526.8	1.000		(1127)
533.1	1.225		

AuCl₃(s) = AuCl₃(g) (1135)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
454.1	0.0127	599.1 (liquid)	0.0882
524.1	.0324		

AuCl₃·mNH₃(s) = (?) + xNH₃(g) (386) (E)Equilibrium reversible with difficulty. In decomposition AuCl₃·12NH₃ gives *P* < 1 at *T* = 255.1; AuCl₃·6NH₃ gives *P* < 1 at room temperature2AuBr(s) = 2Au(s) + Br₂(g) (989)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
484.1	0.085	543.1	0.743
503.1	.234		

AuBr₃(s) = AuBr(s) + Br₂(g) (989)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
438.1	0.085	493.1	0.743
463.1	.234	503.1*	1.000

* Extrapolated.

AuBr₃·mNH₃(s) = (?) + xNH₃(g) (386) (E)*m* = 18 moles, *P* = 1.00 atm. at *T* = 274.1; *m* = 9 moles, *P* = 1.00 atm. at *T* = 284.1. Between these two compounds there exists a complete series of solid solutions. There are also solid solutions of ammonia content greater than 18 moles, and less than 9 moles. Here increase of NH₃ content causes an increase of pressure, e.g., with 21 moles NH₃, *P* = 1.00 atm. at *T* = 258.1.Au(s) + 1/2 I₂ (in CCl₄) = AuI(s) (251)I₂ is 1.088 moles per liter at 298.1°K. (I₂ is 95% saturated; that is, solubility of I₂ is 1.156 moles per liter in CCl₄ at 298.1°)AuI(s) = Au⁺ + I⁻ (251)

In KI(aq) at 298.1°K

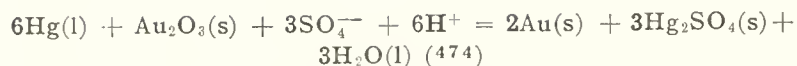
<i>c</i> (KI)	<i>c</i> (ΣAu)	<i>c</i> (I ₂) *
0.1009	0.0106	0.0482
.2508	.0290	.1308
.4038	.0522	.198
1.0096	.1142	.556

* I₂ = total titratable I₂.H₂(g) + Au₂O(s) = 2Au(s) + H₂O(l)*E*_{298.1}⁰ = -1.2 (474) from (249, 250)Au₂O(s) + 2H⁺ = 2Au⁺ + H₂O(l) (2) from (249)In HNO₃(aq)

<i>c</i> (HNO ₃)	<i>c</i> (ΣAu)	<i>c</i> (HNO ₃)	<i>c</i> (ΣAu)
3.32	0.00002	9.13	0.000041
7.76	.000047	11.66	.000086
8.77	.000053		

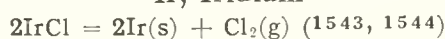
Au₂O₃(s)Δ*F*_{298.1}⁰ = 19 100; Δ*H* = -13 200; Δ*S*_{298.1}⁰ = -108.4 (219)3H₂(g) + Au₂O₃(s) = 2Au(s) + 3H₂O(l) (219); cf. (220, 474, 703, 704, 705)

<i>m</i> (H ₂ SO ₄)	<i>E</i> _{298.1}	
0.0100	1.3639	
.1000	1.3635	Δ <i>F</i> _{298.1} ⁰ = -188 800
1.024	1.3634	<i>E</i> _{298.1} (mean) =
		1.364 ± 0.001



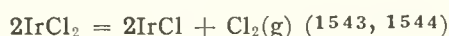
$m(\text{H}_2\text{SO}_4)$	$E_{298.1}$	$m(\text{H}_2\text{SO}_4)$	$E_{298.1}$
0.0506	0.599 ± 0.002	1.031	0.690 ± 0.001
.1031	$.629 \pm 0.002$		

Ir, Iridium



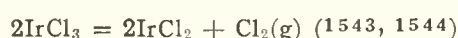
T	P	T	P
971.1	0.201	1 046.1	0.599
1 012.1	.337	1 071.1*	1.000
1 024.1	.424	1 072.1	1.014

* Interpolated.



T	P	T	P
984.1	0.317	1 028.1	0.721
1 010.1	.508	1 044.1	.962
1 022.1	.664	1 046.1*	1.000

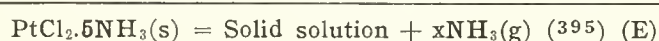
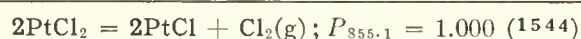
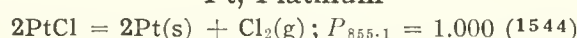
* Extrapolated.



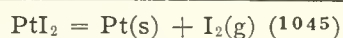
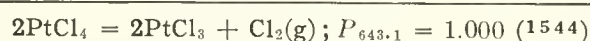
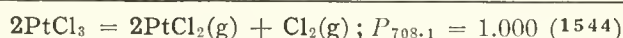
T	P	T	P
859.1	0.063	1 022.1	0.730
916.1	.116	1 036.1*	1.000
989.1	.395	1 038.1	1.014
1 010.1	.603		

* Interpolated.

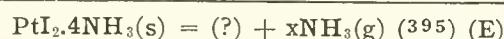
Pt, Platinum



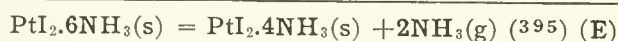
T	P	T	P
277.1	0.395	295.1	1.000
286.1	0.658		$\Delta H = 10 \ 300x$



T	$P \times 10^5$	T	$P \times 10^5$
416.0	0.6316	437.4	3.408
427.5	1.592		

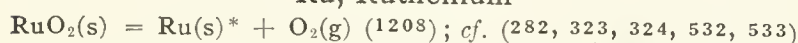


T	P	T	P
399.1	0.171	443.6	1.000 (extrap.)
436.1	0.774		$\Delta H = 16 \ 100x$

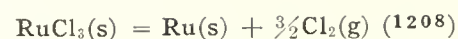


T	P	T	P
265.1	0.743	267.6	0.879
266.1	0.770	269.1	1.000 (extrap.)
			$\Delta H = 18 \ 600$

Ru, Ruthenium

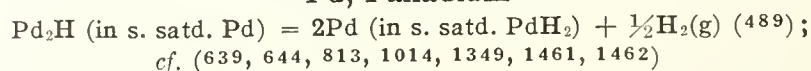


T	P	T	P
1 203	0.026–0.053	1 228	0.066
			$\Delta H = 52 \ 200$

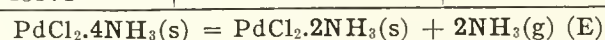
* Ru(s) is slightly soluble in RuO₂(s).

T	P	T	P
962.1	0.154	1 018.1	0.232
993.1	.182	1 039.1	.331
997.1	.186	1 050.1	.387
1 001.1	.200	1 088.1	.693
1 008.1	.225	1 089.1	.739
1 009.1	.211	1 114.1	.957
1 015.1	.246		$H = 94 \ 500$

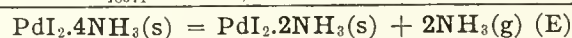
Pd, Palladium



T	P	ΔH
273.1	0.00520	8 780
303.1	.0246	8 700
353.1	.2008	8 450
433.1	1.746	
453.1	2.580	

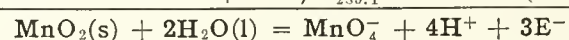
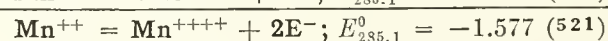
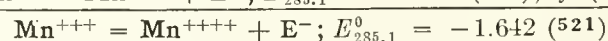
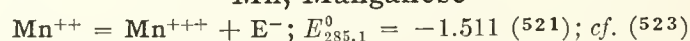


$$P_{483.1} = 1.00; \Delta H = 31 \ 120 \quad (669)$$

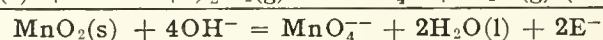
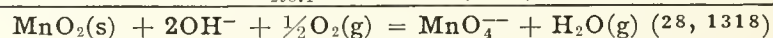


$$P_{383.1} = 1.00; \Delta H = 25 \ 760 \quad (669)$$

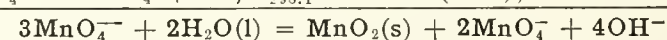
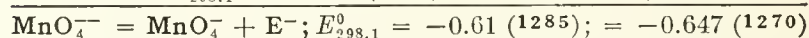
Mn, Manganese



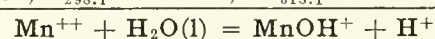
$$E_{298.1}^0 = -1.757 \quad (1270)$$



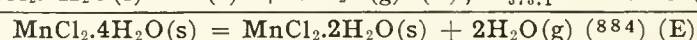
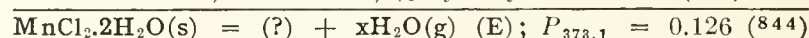
$$E_{298.1}^0 = -0.50 \quad (1285); = -0.66 \quad (1270)$$



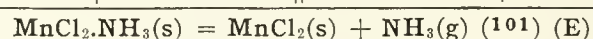
$$K_{318.1} = 53; E_{298.1}^0 = 0.0545; \Delta F_{318.1}^0 = -2 \ 510 \quad (1270)$$



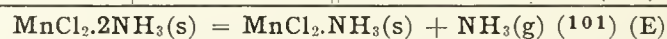
$$\text{At } 373.1^\circ\text{K, for } c = 0.25, \% \text{ hydrolysis} = 0.0017 \quad (800)$$



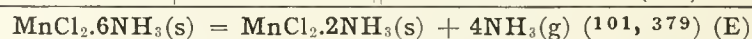
T	P	T	P
293.1	0.0050	333.1	0.103
303.1	0.024	343.1	0.164
313.1	0.0408	353.1	0.239
323.1	0.0605		



T	P	T	P
484.1	0.0124	545.1	0.125
511.1	0.037		$\Delta H = 20 \ 120 \quad (102)$

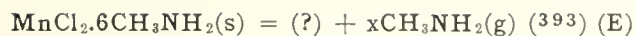


T	P	T	P
452.6	0.086	502.1	0.536
480.6	0.258		$\Delta H = 16 \ 970 \quad (102)$

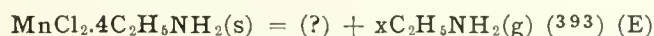


T	P	T	P
332.1*	0.287	353.1	0.618
335.1	0.339	357.1	0.733
338.1	0.303	360.6	0.875
343.1	0.395	363.6	0.987
348.6	0.493	364.1	1.007
350.1*	0.651		$\Delta H = 45 \ 320 \quad (102)$

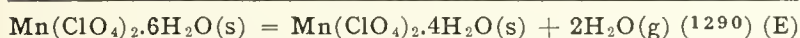
* From (101); all other values from (379).



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
314.6	0.224	346.1	1.00 (interp.)
330.1	0.476	352.6	1.243
337.6	0.684	357.6	1.438
345.6	0.955	$\Delta H = 12\ 250x$	
First decomposition product			
369.6	0.188	395.1	0.658
379.1	0.358	402.6	0.816
388.1	0.517	409.1	0.953
Second decomposition product			
416.6	0.086	448.1	0.263
430.6	0.145	458.1	0.329
438.1	0.197		

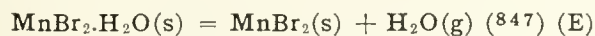


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
256.1	0.022	277.1	0.497
263.1	0.071	283.6	0.782
267.1	0.141	289.1	1.021
272.6	0.330	295.1	1.349
$\Delta H = 10\ 050\text{x}$			

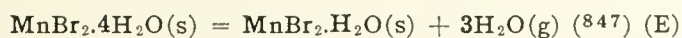


<i>T</i> *	<i>P</i>	<i>T</i> *	<i>P</i>
373.1	0.011	468.1	0.034
383.1	0.018	470.1	0.075
293.1	0.024		

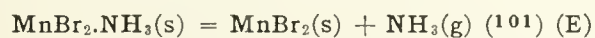
* The compound melts at 388.1°K and changes into the tetrahydrate. Decomposition begins at 423.1°K.



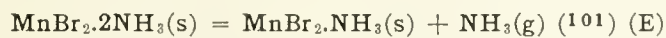
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
413.1	0.074	428.1	0.164
423.1	0.130	433.1	0.205



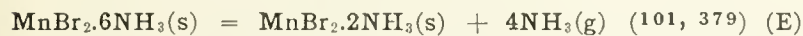
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.0067	373.1	0.263



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
488.1	0.0162	551.1	0.150
503.1	0.0303	$\Delta H = 20\ 030$	

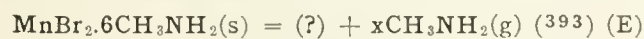


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
455.1	0.0180	503.1	0.129
488.1	0.0742	$\Delta H = 18\ 420$	

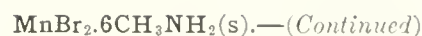


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
380.1*	0.401	397.1	0.724
383.1	0.405	401.1	0.855
387.6	0.487	403.6	0.947
393.1	0.616	$\Delta H = 50\ 720$	

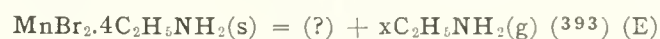
* From (101); all other values from (379).



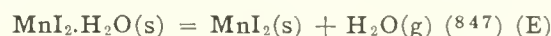
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
340.6	0.125	385.6	0.936
349.6	0.197	387.1	1.000 (interp.)
362.6	0.361	390.1	1.112
374.1	0.605	395.1	1.309
381.1	0.783	$\Delta H = 13\ 850\text{x}$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
Decomposition products			
382.1	0.050	432.1	0.526
392.6	0.100	441.1	0.724
406.6	0.201	452.6	0.882
422.1	0.383		



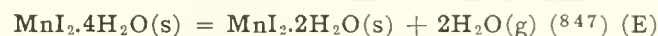
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
284.1	0.124	305.1	1.00 (interp.)
293.6	0.295	305.6	1.021
298.1	0.463	309.6	1.322
301.6	0.674	$\Delta H = 10\ 660\text{x}$	



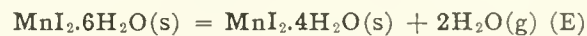
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
393.1	0.171	406.1	0.261
403.1	0.237		



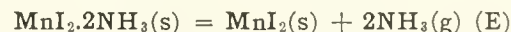
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
339.1	0.025	383.1	0.120
373.1	0.062	393.1	0.147



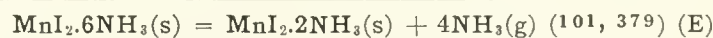
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.1	0.007	373.1	0.109
353.1	0.045	383.1	0.178



$$P_{293.1} = 0.0049 \text{ (}^{847}\text{)}$$

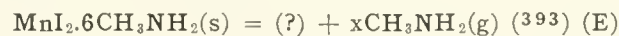


$$P_{481.1} = 0.0146; P_{488.1} = 0.0192 \text{ (}^{101}\text{)}; \Delta H = 39\ 420 \text{ (}^{102}\text{)}$$

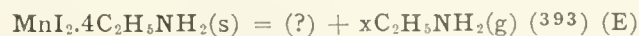


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
398.6	0.138	429.1	0.479
408.1	0.197	435.6	0.625
416.6	0.296	441.6	0.784
422.6	0.368	446.6	0.947
427.1*	0.416	448.6	1.000 (extrap.)
$\Delta H = 56\ 680 \text{ (}^{102}\text{)}$			

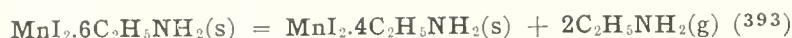
* From (101); all other values from (379).



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
343.1	0.076	386.6	0.711
358.1	0.224	395.1	0.987
369.1	0.349	400.1	1.184
378.1	0.509	405.1	1.382
$\Delta H = 14\ 160\text{x}$			
Decomposition product			
387.6	0.151	427.6	0.875
402.6	0.338	434.1	1.012
416.1	0.616		

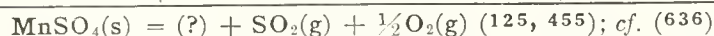


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
285.6	0.133	313.1	0.653
292.6	0.207	318.1	0.913
299.1	0.297	322.6	1.220
304.1	0.392	324.1	1.324
$\Delta H = 11\ 230\text{x}$			

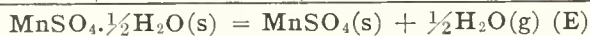


(E)

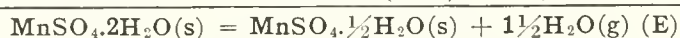
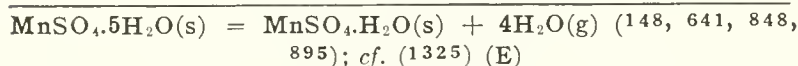
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
241.1	0.132	268.1	0.863
253.1	0.397	269.1	0.916
257.6	0.522	273.1	1.103
263.1	0.684	277.1	1.320

 $\Delta H = 18\,720$ 

<i>T</i> (125)	<i>P</i>	<i>T</i> (455)	<i>P</i>
823–873	1.00	1 308	1.000

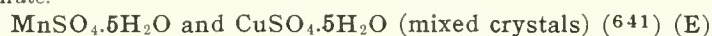
 $P_{293.11} = 0.00 \quad (148)$ 

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.004	333.1	0.037

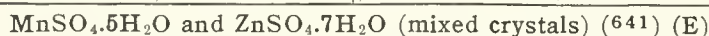
 $\Delta H = 3\,990 \quad (1325)$  $P_{293.11} = 0.00471 \quad (148)$ 

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
282.1	0.00741	293.1	0.01703
283.1	0.00813	293.1*	0.0149
284.1	0.00895	293.1†	0.0176
285.1	0.00975	298.1‡	0.0261
286.1	0.01060	303.28‡	0.0357
287.1	0.01150	305.57‡	0.0409
287.85	0.01210	306.9§	0.0450
288.1	0.01239	308.27‡	0.0487
288.1	0.01329	309.75‡	0.0532
289.1	0.01422	323.28‡	0.0514
291.1	0.01517	333.1*	0.211
292.1	0.016606		

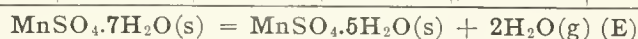
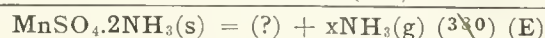
* From (848). † From (641). ‡ From (257). § From (895); all other values from (148) who states that decomposition results in the dihydrate. According to Lineberger (895), the compound is the tetrahydrate instead of the pentahydrate.



Mole % MnSO_4	<i>P</i> at <i>T</i> = 293.1 ± 0.02	Mole % MnSO_4	<i>P</i> at <i>T</i> = 293.1 ± 0.02
100.0	0.0176	14.9	0.0050
97.8	0.0167	8.0	0.0049
93.9	0.0158	3.3	0.0058
84.4	0.0155	0.0	0.0076
23.3	0.0063		

% = Mole % MnSO_4 ; *P* is measured at 293.1 ± 0.02°K

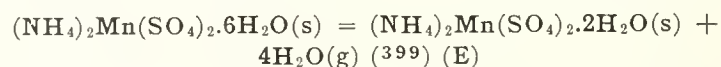
Rhombic 7H ₂ O		Monoclinic 7H ₂ O		Triclinic 5H ₂ O	
%	<i>P</i>	%	<i>P</i>	%	<i>P</i>
0.0	0.0138	36.4	0.0149	90.4	0.0166
1.9	0.0137	46.5	0.0153	95.8	0.0172
5.2	0.0136	58.3	0.0157	100.0	0.0176
10.6	0.0134	67.2	0.0163		
16.3	0.0134	70.2	0.0167		
24.0	0.0136				

 $P_{287.85} = 0.01387 \quad (148)$ 

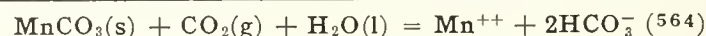
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
375.1	0.096	401.6	0.171
387.1	0.130		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.6	0.343	344.4	0.914
329.6	0.450	346.6	1.000 (extrap.)
338.1	0.626	$\Delta H = 49\,160$	

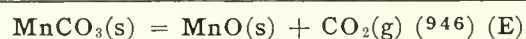


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
339.1	0.203	355.1	0.437
346.1	0.272	358.1	0.488
348.1	0.311	363.1	0.587
352.1	0.372		



At 291.1°K

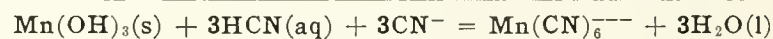
<i>P</i>	<i>m</i> (Mn ⁺⁺)	<i>P</i>	<i>m</i> (Mn ⁺⁺)
1	0.00348	56	0.00696



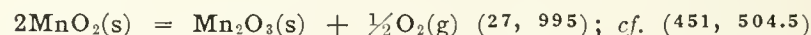
MnCO_3 is always deposited hydrated and cannot be dehydrated without almost complete decomposition. The value of the CO_2 pressure depends upon the amount of retained water and is reproducible for equal amounts of water. For example, for 2.5 % water, $P = 0.0012$ atm. at $T = 523.1^\circ\text{K}$, and for 2.0 % water, $P = 0.004$ atm. at $T = 523.1^\circ\text{K}$. The following data are for a mineral containing 4.63 % FeO , 39.63 % MnO , 12.98 % MgO , 0.074 % SiO_2 and 41.63 % CO_2 :

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
523.1	0.0099	623.1	0.075
573.1	0.022	648.1	0.149
598.1	0.026		

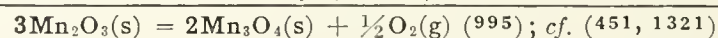
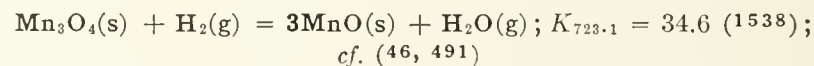
Friedrich (453) finds for Rhodocerosite from Colorado a pressure of 1 atm. at $T = 798.1^\circ\text{K}$. For manganese-bearing dolomites, see (525).

 $K = 0.25 \times 10^7 \quad (990)$ 

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
263.1	0.297	283.1	0.947
273.1	0.524	283.6	1.000
282.1	0.855		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
655.1	0.030	803.1 (995)	0.209
721.1	.164	809.1	1.36
751.1	.263	1 213.1 (995)	1.000

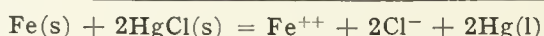


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 213.1	0.209	1 363.1	1.000

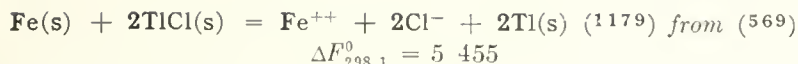
AgMnO₄; see p. 272

Fe, Iron

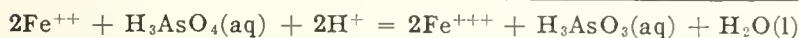
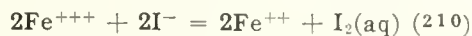
$\text{Fe}^{++}; E_{298.1}^0 = 0.441; \Delta F_{298.1}^0 = -20\,350 \quad (885). \Delta F_{298.1}^0 = -20\,240 \quad (1179), \text{ revised value}$



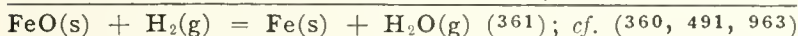
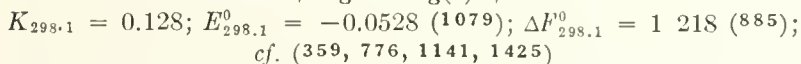
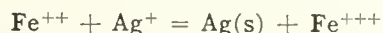
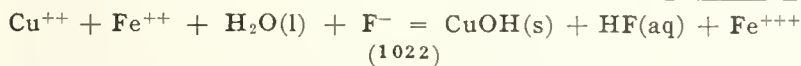
$E_{298.1}^0 = 0.7061; \Delta F_{298.1}^0 = -32\,585; \text{ Const.}_{298.1} = -7.9750 \quad (569, 1179); \text{ cf. } (1216)$



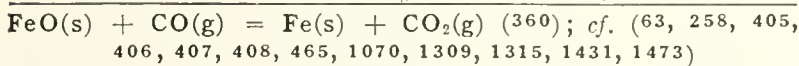
$m_{(\text{Fe}^{++})}$	$m_{(\text{Tl}^+)}$	$m_{(\text{Cl}^-)}$	$\log m^{1/2}$	$\mu^{1/2}$
0.0453	0.0042	0.0948	-1.1301	0.3743



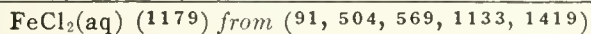
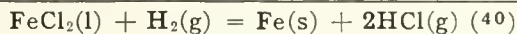
$T \ (702) \dots\dots\dots$	290.1	380.1	400.1
$K \dots\dots\dots$	2.1×10^{-5}	$0.0354 \pm 15\%$	$0.117 \pm 20\%$



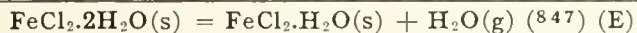
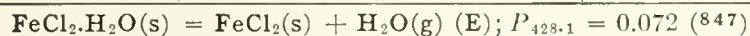
T	K	T	K
951.1	0.56	1 138.1	0.78
998.1	.61	1 182.1	.84
1 045.1	.67	1 225.1	.88
1 091.1	.73	1 295.1	.96



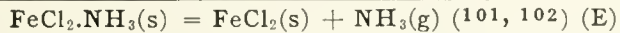
T	K	T	K
873.1	0.871	1 173.1	0.466
973.1	0.678	1 273.1	0.403
1 073.1	0.552		



m	$\log \gamma$	m	$\log \gamma$
0.001	-0.048	0.05	-0.205
.002	-0.065	.1	-0.236
.005	-0.095	.2	-0.252
.01	-0.124	.5	-0.234
.02	-0.157	1.0	-0.175



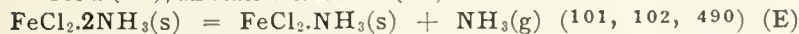
T	P	T	P
363.1	0.039	393.1	0.171
373.1	0.063	398.1	0.247
383.1	0.099		



T	P	T	P
487.6	0.0076	550.1	0.0716
503.1	0.014	564.1*	0.132 (extrap.)

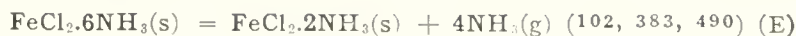
$\Delta H = 20 \ 760^*$

* From (102); all other values from (101).



T	P	T	P
369.1	0.001	485.1	0.149
408.1	0.007	498.1*	0.132 (extrap.)
416.1	0.008	503.1†	0.159
430.1	0.014	508.1	0.291
433.1	0.017	528.1	0.497
439.1	0.025	530.1	0.546
447.1	0.036	534.1	0.625
455.1	0.050	543.1	0.791
459.1	0.055	550.1†	0.730
478.1	0.082	545.1	0.957

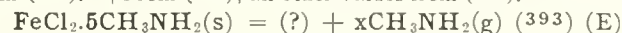
* From (102). † From (101); all other values from (490).



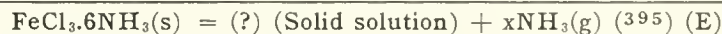
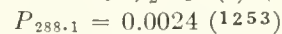
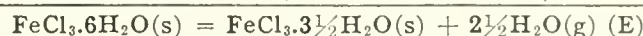
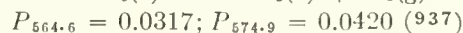
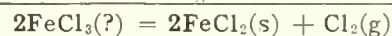
T	P	T	P
287.1	0.007	356.1	0.250
307.1	0.011	358.6*	0.267
319.1	0.012	366.1*	0.355
323.1	0.014	368.1	0.437
328.1	0.033	373.1	0.559
329.1	0.038	373.6*	0.493
337.6*	0.108	375.1	0.611
338.1	0.084	378.8*	0.645
343.1	0.122	379.1	0.741
344.1†	0.132	381.9*	0.720
347.1	0.153	385.6*	0.849
348.1*	0.171	388.1*	0.941
353.1	0.197	388.1	0.978

$\Delta H^\dagger = 49 \ 000$

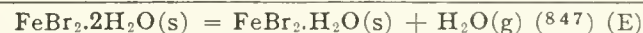
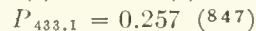
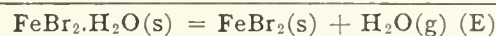
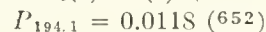
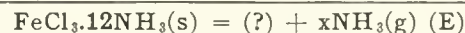
* From (383). † From (102); all other values from (490).



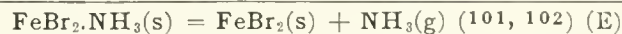
T	P	T	P
332.1	0.167	370.1	1.00 (interp.)
344.6	0.366	371.6	1.055
353.6	0.558	378.1	1.305
363.1	0.795		$\Delta H = 13 \ 180x$



T	P	T	P
300.6	0.147	331.1	0.616
311.4	0.263	338.1	0.771
322.1	0.426	343.6	0.939



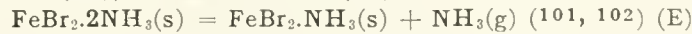
T	P	T	P
383.1	0.118	403.1	0.276
393.1	0.158		



T	P	T	P
488.1	0.0075	550.1	0.0809
503.1	0.0128	564.6*	0.132 (interp.)

$\Delta H = 20 \ 780^*$

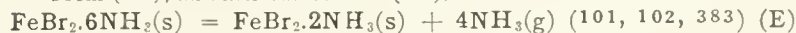
* From (102); all other values from (101).



T	P	T	P
488.1	0.0151	514.1*	0.132 (interp.)
503.1	0.0309	550.1	0.166

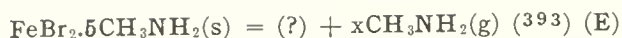
$\Delta H = 19 \ 870^*$

* From (102); all other values from (101).

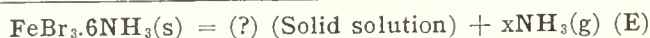


T	P	T	P
336.1	0.029	388.4	0.230
348.1	0.045	396.6	0.311
358.6	0.063	403.6	0.433
369.6	0.100	416.1	0.714
378.6	0.150	422.1	0.899
380.1	0.166	426.1	1.019

$\Delta H = 53 \ 360 \ (102)$



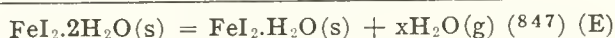
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
358.1	0.100	398.6	0.882
365.6	0.145	401.1	1.000 (interp.)
374.1	0.262	403.6	1.087
383.1	0.434	409.1	1.313
390.6	0.629	$\Delta H = 14\,400\text{x}$	



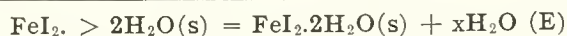
$$P_{318.1} = 1.000; \Delta H = \text{ca. } 11\,200\text{x} \quad (395)$$



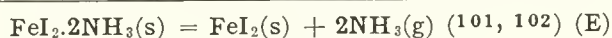
$$P_{433.1} = 0.145 \quad (847)$$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
363.1	0.101	383.1	0.211
373.1	0.151	393.1	0.306

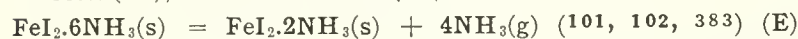


Vapor pressures very similar to those of saturated solution (847)



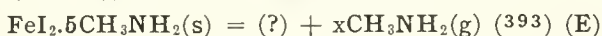
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
488.1	0.0080	551.1	0.112
504.1	0.0159	560.1*	0.132 (extrap.)
$\Delta H = 40\,920^*$			

* From (102); all other values from (101).

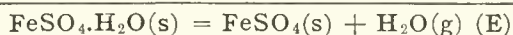


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
385.1	0.082	437.1	0.467
398.1	0.116	445.6	0.628
408.1*	0.132	450.6	0.746
408.6	0.151	453.6	0.822
418.6	0.237	457.1	0.932
426.1*	0.271	460.6	1.053
429.6	0.363	$\Delta H = 58\,000 \quad (102)$	

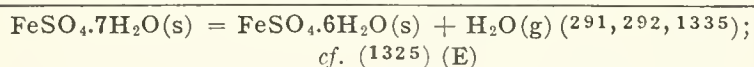
* From (101, 102); all other values from (383).



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
360.6	0.099	404.1	0.875
376.1	0.230	407.1	1.000 (interp.)
385.6	0.380	409.1	1.055
393.6	0.566	415.1	1.284
398.1	0.692	$\Delta H = 14\,630\text{x}$	

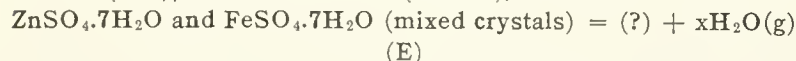


$$P_{293.1} = 0.0026; P_{333.1} = 0.049 \quad (848)$$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
298.1*	0.01915	317.55	0.06495
303.77	0.04301	318.53	0.10106
313.06	0.07203		

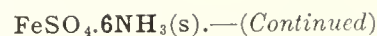
* From (1335); all other values from (291, 292).



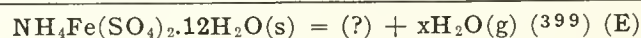
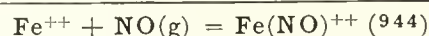
For mixed crystals with from 37.45 to 96.28% FeSO_4 , each compound as if uninfluenced by the other is dehydrated to the hexahydrate (1241). Similar data also given for the rhombic mixed crystals



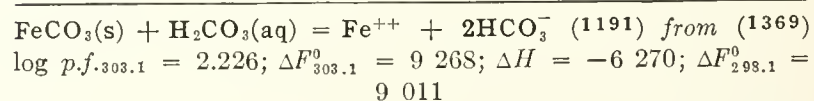
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
346.1	0.197	361.6	0.461
355.1	0.337	367.6	0.611



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
371.6	0.725	380.1	0.974
375.6	0.845	382.6	1.037
$\Delta H = 27\,300$			
First decomposition product			
369.1	0.349	387.1	0.947
379.1	0.643	387.6	1.019
384.6	0.814		
Second decomposition product			
373.6	0.246	401.1	0.647
386.6	0.484	413.6	0.743
391.6	0.555	432.6	0.841

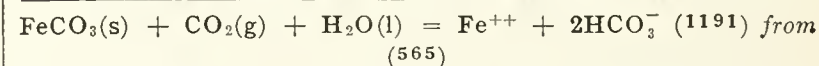


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
298.1	0.008	314.1	0.051
306.1	0.024		

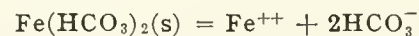


$$\log p.f._{303.1} = 2.226; \Delta F_{303.1}^0 = 9\,268; \Delta H = -6\,270; \Delta F_{298.1}^0 = 9\,011$$

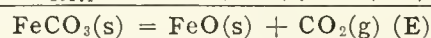
$c(\text{H}_2\text{CO}_3)$	$c(\text{Fe}^{++})$	$c(\text{HCO}_3^-)$	$\mu_c^{1/2}$	$\log(1/K_c^{1/3})$
0.1868	0.00245	0.00490	0.086	2.1673
.1985	.00257	.00514	.088	2.1553
.2168	.00262	.00524	.089	2.1596
.2327	.00274	.00548	.091	2.1505
.2960	.00303	.00606	.095	2.1416
.3116	.00304	.00608	.096	2.1476
.3294	.00311	.00622	.097	2.1460
.3745	.00315	.00630	.097	2.1587
.3153	.00318	.00636	.098	2.1298
.4046	.00332	.00664	.100	2.1471
.4750	.00348	.00696	.102	2.1498
.6600	.00402	.00804	.110	2.1350
.7154	.00418	.00836	.112	2.1298
.7600	.00434	.00868	.114	2.1222



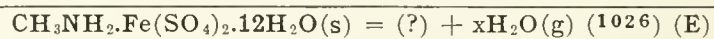
At 291.1°K, $\mu_c^{1/2} = 0.136$; $p_{\text{CO}_2} = 1$; $\log(1/K_m)^{1/3} = 2.004$; $\log p.f. = 2.108$; $\Delta F_{291.1}^0 = 8\,429$; $\Delta H = -11\,170$; $\Delta F_{298.1}^0 = 8\,900$; values probably too high



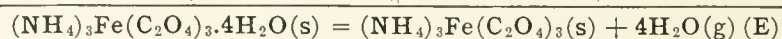
$$\Delta F_{291.1}^0 = 8\,336 \quad (1191) \text{ from } (565)$$



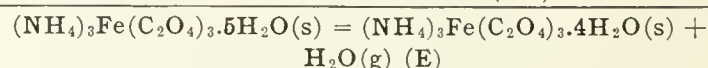
At $T = \text{ca. } 653^\circ\text{K}$, $P = 1 \text{ atm.}$, from Ivigtut and Neudorf; at $T = \text{ca. } 688^\circ\text{K}$, $P = 1 \text{ atm.}$, ppt. FeCO_3 (453)



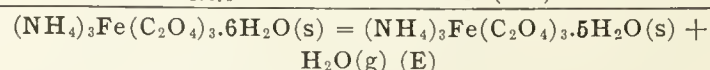
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
295.6	0.0059	307.6	0.033
298.1	0.009	308.1	0.0380
300.6	0.013	310.1	0.039
303.1	0.0191	313.1	0.051
305.1	0.024	315.1	0.062



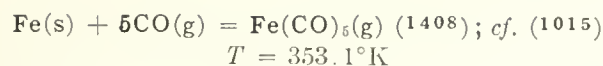
$$P_{298.1} = 0.0024 - 0.0058 \quad (916)$$



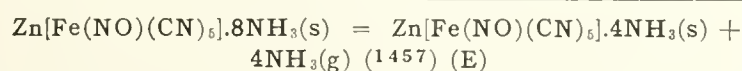
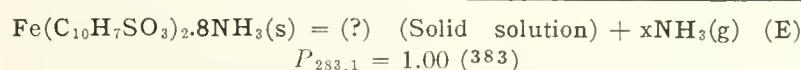
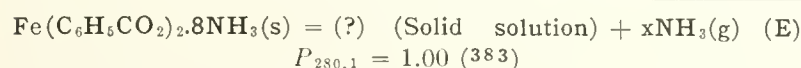
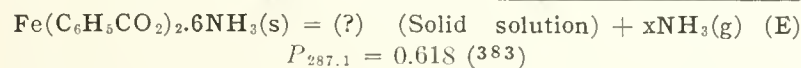
$$P_{298.1} = 0.0058 - 0.0116 \quad (916)$$



$$P_{298.1} = 0.0116 - 0.0176 \quad (916)$$

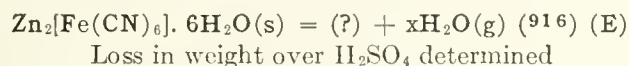


P_{CO}	$P_{\text{Fe(CO)}_5}$	$\log K$
0.579	0.00120	-1.734
.737	.00314	-1.841
.868	.00762	-1.811
.918	.00799	-1.912
.963	.0100	-1.918
1.121	.0200	-1.947
1.126	.0207	-1.942
1.270	.0339	-2.002
1.479	.0586	-2.082

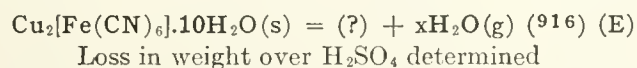


T	P	T	P
252.1	0.376	269.1*	0.825
258.1	0.536	272.1	0.928
264.1	0.687		

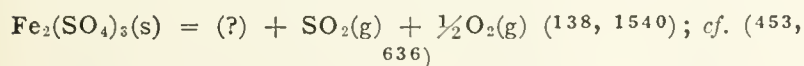
* The decomposition results in solid solutions. For the pure compound $P = 1.00$ at ca. 268.1°K .



P	Moles H_2O	P	Moles H_2O
0.02838	2.45	0.00580	4.18
0.02579	3.14	0.00230	4.72
0.02319	3.32	0.00074	5.44
0.01769	3.60	0.0003	5.96
0.0116	3.90	0.0000	5.96

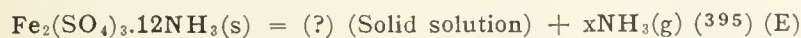


P	Moles H_2O	P	Moles H_2O
0.02838	0.95	0.00580	7.14
0.02579	2.28	0.00230	7.82
0.02319	3.60	0.00074	8.74
0.01769	4.92	0.0003	9.30
0.0116	6.14	0.0000	9.77

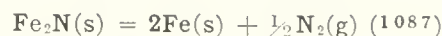


T	P	T	P
909.1*	0.129	953.1	0.333
919.1	.093	953.1*	.331
948.1	.290	973.1	.586
948.1*	.291	994.1	.987

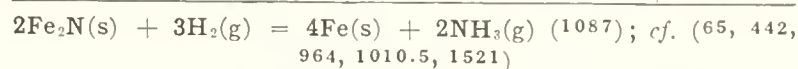
* From (138); all other values from (1540).



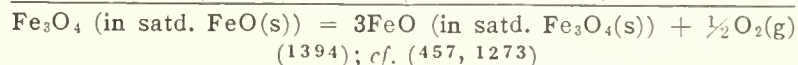
T	P	T	P
273.1	0.105	302.4	0.625
281.6	0.167	309.1	0.928
288.3	0.255	310.1	0.980
295.3	0.382		$\Delta H = 10\,900\text{x}$



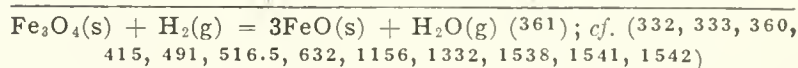
$P_{733.1}$	20 000	102 000	590 000	41 000
Solid phase, atomic ratio Fe/N....	17:1 to 9:1	7.7:1	4.9:1	2.6:1



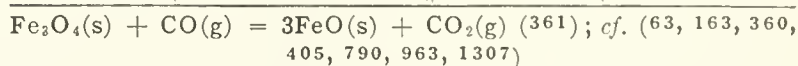
$K_{733 \pm 5}$	Atomic ratio, Fe/N in solid phase	$K_{733 \pm 5}$	Atomic ratio, Fe/N in solid phase
1.0	17.1	5.2	7.72
0.8	9.5	30	4.87
1.2	9.0	2.1	2.59



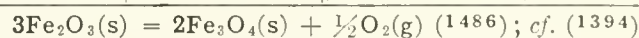
%FeO in solid	P_{1373}	P_{1473}
0.90	0.00049	0.0066
1.80	.00029	.0047
2.71	.00022	.0039
4.52	.00017	.0034
9.09	.00013	.00283
13.70	.00012	.00236
18.37	.000111	.00204
23.07	.000091	.00167
27.83	.000068	.00112
31.03	<.000006	<.00005



T	K	T	K
951.1	1.27	1 138.1	4.60
998.1	1.93	1 182.1	5.52
1 045.1	2.68	1 225.1	6.75
1 091.1	3.54	1 295.1	8.3



T	K	T	K
1 091.1	2.71, 2.49	1 225.1	3.61
1 138.1	2.83	1 312.1	4.35, 4.50, 4.56

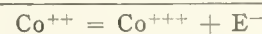


T	P	T	P
1 373	0.0066	1 613	0.182
1 423	.0092	1 623	.218
1 473	.0118	1 633	.266
1 523	.0263	1 653	.391
1 573	.0782	1 663	.464
1 593	.119	1 773	.597

Co, Cobalt



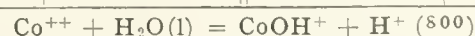
$$E_{298.1}^0 = -0.255 \quad (812); \text{ cf. } (1061); = -0.262 \quad (804); = -0.307 \quad (1317); = -0.292 \quad (288)$$



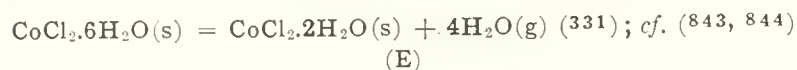
$$E_{273.1}^0 = -1.779; E_{298.1}^0 = -1.817 \quad (812); \text{ cf. } (689, 1094)$$



T	K	T	K
728	14	1 023	19

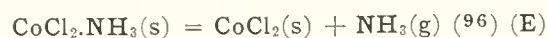


c	% Hydrolysis			
	In $\text{CoCl}_2\text{(aq)}$		In $\text{Co(NO}_3)_2\text{(aq)}$	
	358.6°K	373.0°K	358.6°K	373.0°K
0.0156	0.0147	0.0196	0.0152	0.0154
.0625	.0173	.0172	.00328	.0048

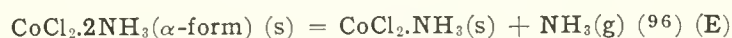


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.0071*	313.1	0.0279*
296.15	0.0084	317.02	0.0366
297.29	0.0089	318.1	0.0389*
298.1	0.0095*	319.94	0.0438
301.78	0.0126	321.7	0.0505
303.1	0.0134*	322.33	0.0522
305.75	0.0163	323.1	0.0550
308.1	0.0196*	324.68	0.0613
309.08	0.0217	325.35†	0.0639†
312.57	0.0270		

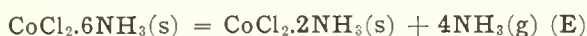
* Interpolated. † Transition point.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
481.1	0.00376	503.1	0.01059
488.1	0.00495	$\Delta H = 21 \ 100 \ (102)$	



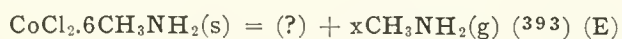
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
409.6	0.0091	503.1	0.1084
426.6	0.0175	507.1	0.1121
441.1	0.0355	509.7	0.1183
456.6	0.0559	$\Delta H = 18 \ 670 \ (102)$	



<i>T</i> (102)	<i>P</i>	<i>T</i> (96)	<i>P</i>
362.1	0.132	410.1	1.053
$\Delta H = 51 \ 600 \ (102)$			

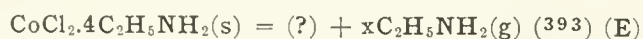
On rapid heating to 430.1°K, no mixed crystals form. On slow heating mixed crystals of the formula $\text{CoCl}_2 \cdot 6\text{NH}_3 \cdot 2\frac{3}{4}\text{H}_2\text{O}$ - $\text{CoCl}_2 \cdot 2\text{NH}_3$ appear between 425.1 and 448.1°K. Disregarding mixed crystals, Ephraim (379) obtained the following results:

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
355.6	0.099	399.1	0.559
365.6	0.133	405.1	0.708
374.6	0.205	409.1	0.816
384.1	0.304	412.6	0.925
391.1	0.401		

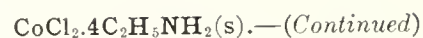


T	P	T	P
333.1*	0.197	370.6	0.822
345.6	0.349	376.1	0.987
355.6	0.520	381.1	1.171
363.1	0.664	$\Delta H = 13\ 420\text{x}$	
Decomposition product			
377.1	0.074	406.6	0.221
387.6	0.109	423.6	0.358
401.6	0.186	433.1	0.446

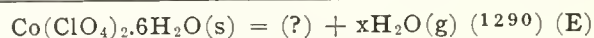
* The compound melts at 323.1°K.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
285.1	0.145	303.1	0.537
294.1	0.270	307.1	0.724

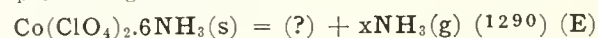


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
309.6	0.921	312.6	1.250
311.1	1.086	$\Delta H = 10 \ 850\text{x}$	



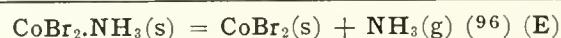
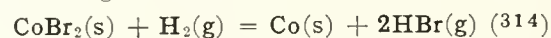
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
360.1	0.021	455.1	0.0547
403.1	0.042	470.1	0.0649
418.1	0.0518	480.1	0.079
426.1	0.0547	485.1	0.124
443.1*	0.0547	493.1	0.337

* Decomposition begins at 453.1°K.

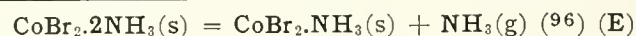


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
350.1	0.0100	400.1	0.0901
370.1	0.0259	410.1	0.1280
380.1	0.0359	421.1*	0.1737
390.1	0.0561		

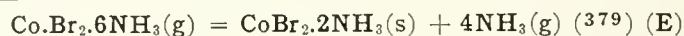
* Decomposition begins at 421.1°K.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
434.5	0.00038	461.7	0.00161
454.9	0.00130	481.5	0.00468
$\Delta H = 21 \ 000 \ (102)$			

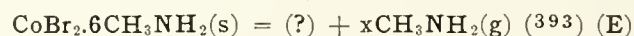


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
425.5	0.00057	454.9	0.00268
433.6	0.000914	$\Delta H = 20 \ 170 \ (102)$	

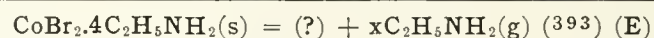


<i>T</i> *	<i>P</i>	<i>T</i> *	<i>P</i>
377.1	0.097	432.6	0.533
386.1	0.117	438.1	0.649
394.6	0.145	443.6	0.776
404.6	0.184	448.1	0.900
415.1	0.272	449.6	0.958
423.1	0.367	451.1	1.000 (extrap.)

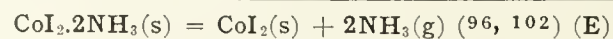
* According to Biltz and Fetkenheuer (96), the decomposition results in an unbroken series of mixed crystals. For the pure substance, $P = 0.132$ at $T = 394.1 \ (102)$; $P = 0.262$ at $T = 409.9 \ (96)$; $\Delta H = 56 \ 000 \ (102)$.



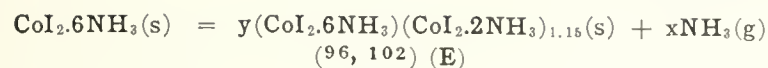
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
347.6	0.084	387.6	0.491
355.6	0.109	398.6	0.821
366.1	0.166	404.6	1.034
376.6	0.279	410.6	1.268
$\Delta H = 14 \ 470\text{x}$			



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
303.6	0.122	335.1	0.830
315.1	0.255	338.6	0.989
325.6	0.488	343.1	1.220
330.6	0.666	$\Delta H = 12 \ 210\text{x}$	

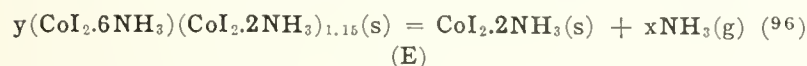


<i>T</i> (96)	<i>P</i>	<i>T</i> (102)	<i>P</i>
409.6	0.00022	545.1	0.132 (extrap.)
426.6	0.00123	$\Delta H = 39 \ 800 \ (102)$	

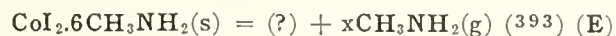


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
410.1	0.087	454.1	0.600
414.1*	0.132	$\Delta H = 14\,700x^*$	

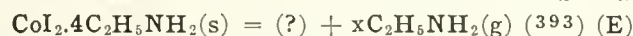
* From (102); all other values from (96). Somewhat smaller values of pressure, which disregard mixed crystals, are given by (379).



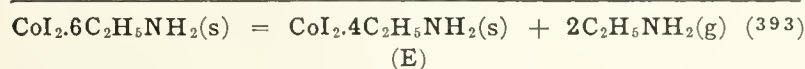
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
410.1	0.060	454.6	0.374



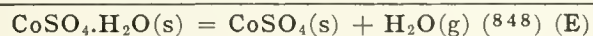
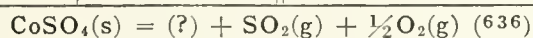
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
368.1	0.093	413.1	0.571
377.1	0.128	418.6	0.687
389.6	0.207	423.6	0.796
394.1	0.257	431.1	0.993
399.6	0.330	436.1	1.175
408.1	0.480	$\Delta H = 15\,580x$	
Decomposition product			
377.1	0.074	406.6	0.221
387.6	0.119	423.6	0.358
401.6	0.186	433.1	0.446



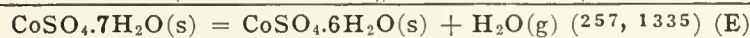
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
313.6	0.068	349.1	0.671
324.1	0.158	355.1	0.863
331.6	0.266	360.1	1.057
338.6	0.400	364.6	1.249
$\Delta H = 12\,750x$			



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
256.1	0.132	280.6	0.789
263.1	0.236	284.1	0.921
268.1	0.384	286.6	1.053
273.2	0.553	291.6	1.276
276.6	0.658	$\Delta H = 21\,860$	

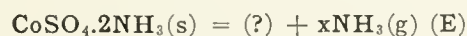


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
290.1	0.0157	333.1	0.228
293.1	0.0180	353.1	0.388

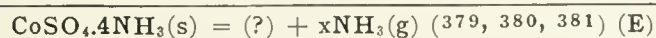


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
298.1*	0.02181	309.75	0.050
298.1	0.0224	313.32	0.0637
305.6	0.0378	318.16	0.087

* From (1335); all other values from (257).

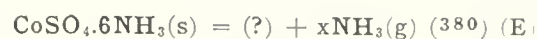


$$P_{420.1} = 0.053 \quad (379, 380, 381)$$

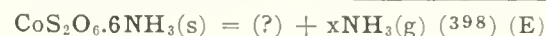


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
376.6	0.186	397.1	0.583
385.6	0.337	404.6	0.855
386.6*	0.276	408.1*	0.863
397.1*	0.532	409.1	1.080
$\Delta H = 14\,780x$			

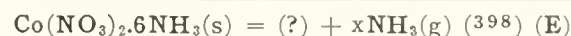
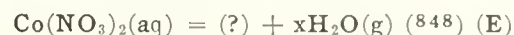
* Substance previously heated for a long time.



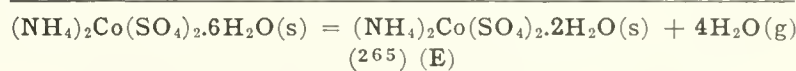
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
339.1	0.114	375.6	0.637
353.6	0.229	379.1	0.708
363.1	0.384	382.6	0.784
371.6	0.545	389.6	1.000 (extrap.)
$\Delta H = 13\,980x$			



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
373.6	0.116	414.6	0.599
384.1	0.175	423.1	0.803
394.1	0.264	430.1	0.974
406.6	0.437	430.6	1.000



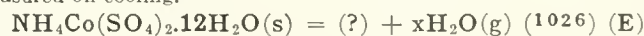
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
294.1	0.017	425.1	0.620
382.6	0.170	426.1	0.704
404.1	0.275	430.6	0.855
410.6	0.357	433.1	1.000 (extrap.)



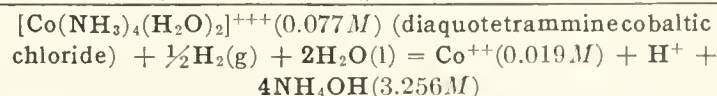
$$\Delta H = 59\,200; \log P = 4.719 + 843.4/T - 388\,300/T^2$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
308.4	0.0075	327.1	0.0339*
310.6	0.0095*	334.8	0.0542
316.9	0.0155	340.4	0.0772
320.2	0.0204*	355.3	0.1854
323.8	0.0254		

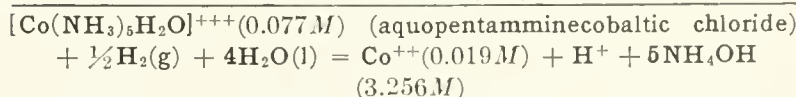
* Measured on cooling.



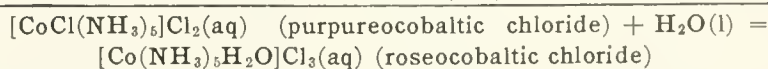
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.0086	303.1	0.0664
295.6	0.0256	308.6	0.1197
301.1	0.053		



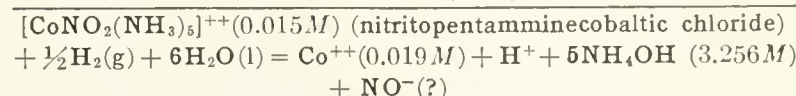
$$E_{298.1} = 0.1034 \quad (812)$$



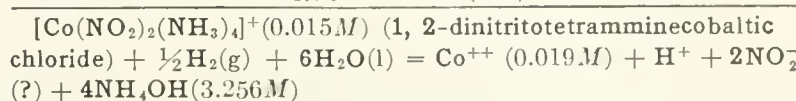
$$E_{298.1} = 0.0884 \quad (812)$$



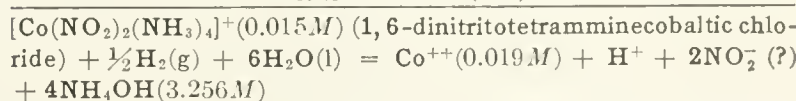
$$K_{373.1} = 1.4 \quad (1130)$$



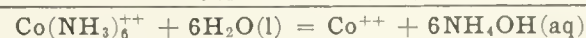
$$E_{298.1} = 0.0929 \quad (812)$$



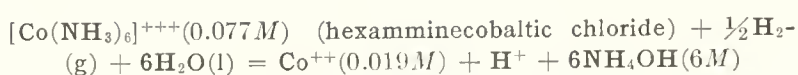
$$E_{298.1} = 0.0674 \quad (812)$$



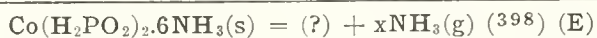
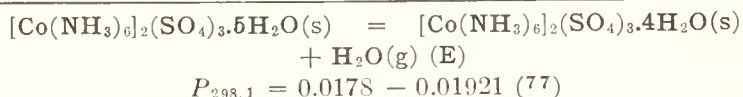
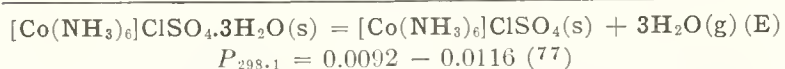
$$E_{298.1} = 0.1156 \quad (812)$$



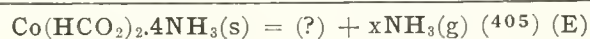
$$K_{298.1} = 1.25 \times 10^{-5} \quad (812)$$



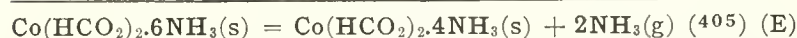
$$E_{298.1} = 0.1558 \text{ (812)}$$



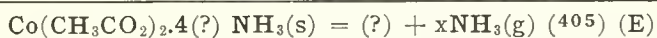
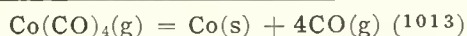
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.161	315.1	0.605
304.1	0.305	322.1	0.892
310.1	0.455	324.1	1.000 (extrap.)



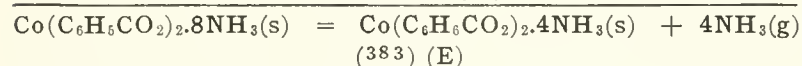
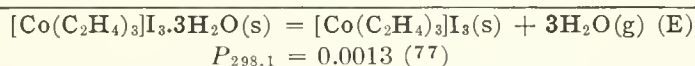
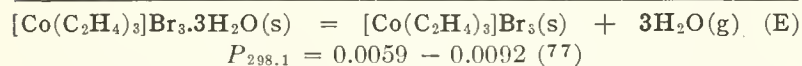
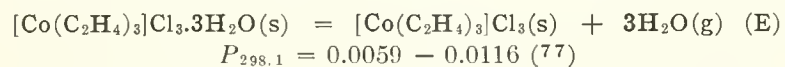
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
297.1	0.036	355.1	0.629
323.1	0.117	363.6	0.917
337.1	0.261	365.1	1.000 (extrap.)
347.1	0.379		



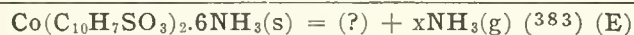
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
258.1	0.129	287.1	0.670
273.1	0.296	293.1	0.888
279.1	0.424	294.6	1.000 (extrap.)
284.1	0.539		



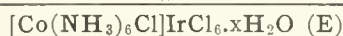
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
287.1	0.088	323.1	0.714
300.1	0.183	327.1	0.914
312.1	0.384	328.6	1.000
318.1	0.554		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
278.6	0.161	304.6	0.939
285.6	0.303	305.6	1.000
295.6	0.547		



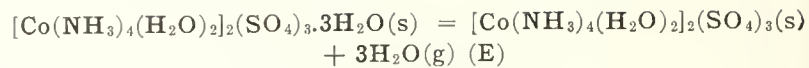
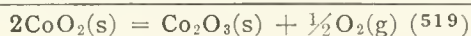
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
263.1	0.317	284.1	0.618
268.1	0.375	291.1	0.947
273.1	0.447	291.6	1.000
278.1	0.520		



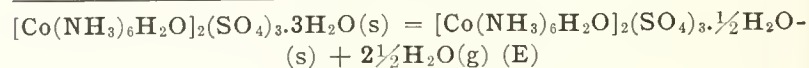
Maximum H_2O = 12.52% or 4.13 moles; the dehydration proceeds continuously at 298.1°K (77)



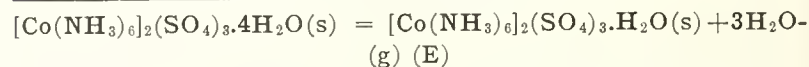
Maximum H_2O = 9.48% or 2.68 moles for *cis*-salt; = 8.0% or 2.26 moles for *trans*-salt. The dehydration proceeds continuously at 298.1°K (77)



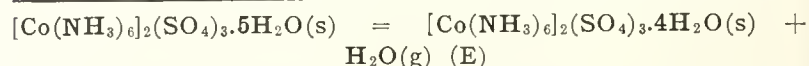
$$P_{298.1} = 0.0022 \text{ (77)}$$



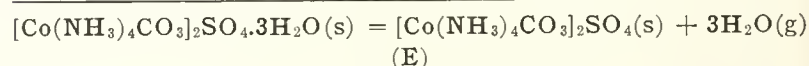
$$P_{298.1} = 0.0022 \text{ (77)}$$



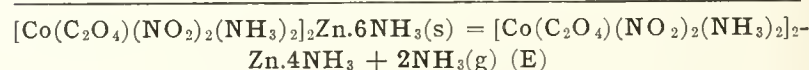
$$P_{298.1} = 0.0057 - 0.0092 \text{ (77)}$$



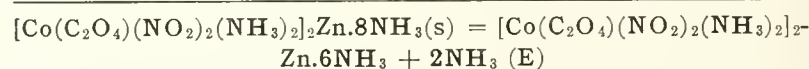
$$P_{298.1} = 0.0178 - 0.0192 \text{ (77)}$$



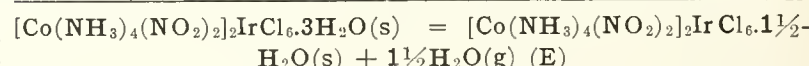
$$P_{298.1} = 0.0099 - 0.0120 \text{ (77)}$$



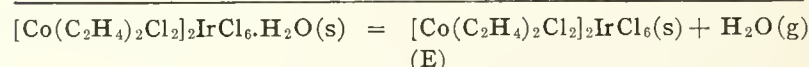
$$P = 1.00 \text{ above room temperature (403)}$$



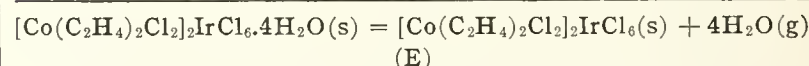
$$P = 1.00 \text{ between room temperature and } 258.6^\circ\text{K} \text{ (403)}$$



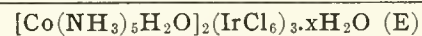
$$P_{298.1} = 0.0013 - 0.0022 \text{ (77)}$$



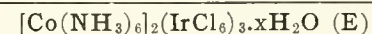
$$P_{298.1} = 0.0178 - 0.0232 \text{ for } \textit{trans}\text{-salt (77)}$$



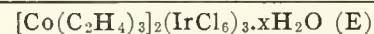
$$P_{298.1} = 0.0013 - 0.0022 \text{ for } \textit{cis}\text{-salt (77)}$$



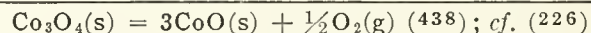
Maximum H_2O = 14.98%. The dehydration proceeds continuously at 298.1°K (77)



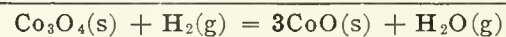
Maximum H_2O = 21.39%; the dehydration proceeds continuously at 298.1°K (77)



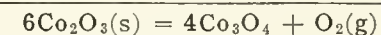
Maximum H_2O = 12.65% or 12.29 moles; the dehydration proceeds continuously at 298.1°K (77)



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 073	0.013	1 183	0.241
1 123	0.037	1 223	0.686
1 173	0.189	1 243	1.007

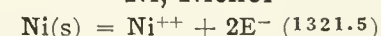


$$K_{723.1} = 34.4 \text{ (1538); cf. (491)}$$

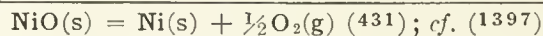


$$P_{645.1} = 1.00 \text{ (226)}$$

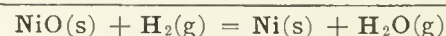
Ni, Nickel



<i>T</i>	<i>c</i> (NiSO ₄)	<i>E</i>
297.1	0.5	0.48 ± 0.005
368.0	0.5	0.44



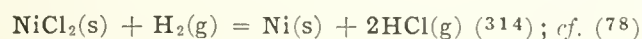
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 273	0.0026	1 473	0.0171
1 373	.0072	1 318	.0237



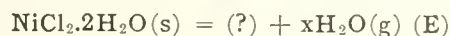
$$K_{723.1} = 15 \text{ (1538); cf. (491, 1282)}$$



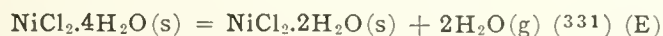
<i>T</i>	<i>c</i>	% Hydrolysis
358.6	0.0625	0.0084
373	.0156	.0194
373	.0625	.0142
373	.25	.0131



<i>T</i>	<i>K</i>	<i>T</i>	<i>K</i>
583	0.0066	688	0.156
613	.024	718	1.000

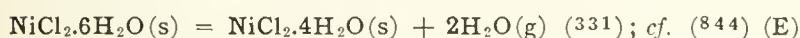


$$P_{373.1} = 0.164 \text{ (843, 844)}$$



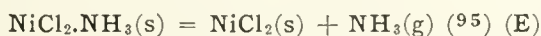
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.0064*	320.79	0.0347
293.1	0.0068*	323.1	0.0392*
298.1	0.0078*	327.60	0.0532
298.10	0.0080	327.73	0.0536
303.1	0.0100*	328.1	0.0516*
305.41	0.0117	332.73	0.0741
308.1	0.0145*	333.1	0.0767*
311.30	0.0187	338.1	0.1030*
313.1	0.0214*	339.44	0.1106
318.1	0.0299*		

* Interpolated.



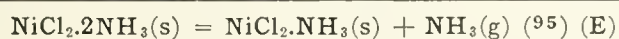
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.0086*	304.1	0.0212
293.1	0.0100*	308.1	0.0275*
298.1	0.0138*	308.15	0.0275
303.1	0.0196*	308.35	0.0296†
303.8	0.0200		

* Interpolated. † Transition point.



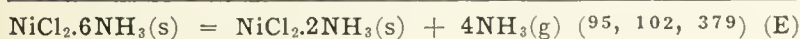
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
538.1	0.026	612.1	0.293
557.6	0.050	628.1	0.462
584.1	0.132	646.1	0.934
595.1	0.209	648.1	1.000 (extrap.)

$$\Delta H = 21\,460$$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
488.1	0.014	569.1	0.6746
512.1	0.0809	578.1	0.876
533.1	0.175	584.1	0.934
555.1	0.353	586.1	1.000 (extrap.)

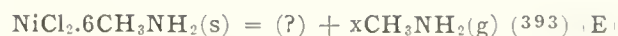
$$\Delta H = 19\,000 \text{ (102)}$$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
403.1*	0.159	430.6	0.503
411.1	0.211	437.1	0.638
415.1*	0.272	442.1	0.776
417.6	0.287	445.6	0.868
426.1	0.414	448.1*	0.934
428.1	0.458	450.1	1.020

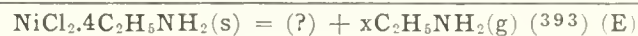
$$\Delta H = 56\,600 \text{ (102)}$$

* From (379); all other values from (95).



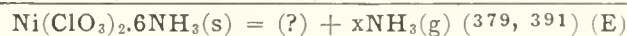
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
356.6	0.0559	398.1	0.567
366.6	0.106	407.1	0.804
376.1	0.183	413.1	1.000 (interp.)
388.1	0.343	417.1	1.140

$$\Delta H = 14\,870\text{x}$$



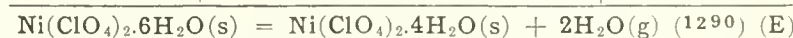
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
322.1	0.047	381.1	0.721
333.6	0.067	385.6	0.918
344.1	0.138	387.1	1.000 (interp.)
360.6	0.305	390.6	1.237
375.1	0.545		

$$\Delta H = 13\,850\text{x}$$



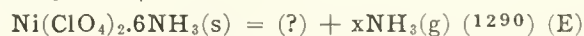
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
399.1	0.066	432.1	0.184
413.6	0.098	477.1	1.000 (extrap.)

$$\Delta H = 17\,500\text{x}$$

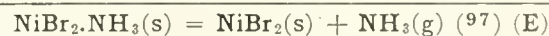
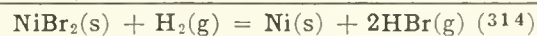


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
357.1	0.0145	515.1	0.0579
385.1	0.0214	530.1	0.0666
410.1	0.0345*	535.1	0.0882
460.1	0.0482	540.1	0.1803
505.1†	0.0482	541.1	0.2355

* Transition point. † Decomposition begins at 513.1°K.

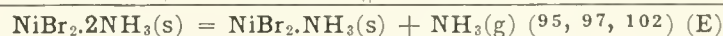


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
380.1	0.0099	475.1	0.091
398.1	0.016	480.1	0.1337
450.1	0.024	484.1	0.1375
470.1	0.0676		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
549.3	0.0786	609.1	0.501
572.1	0.159		

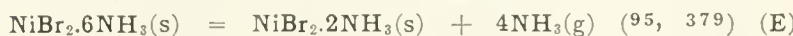
$$\Delta H = 20\,780 \text{ (102)}$$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
480.1	0.004	577.1	0.2217
491.1	0.011	582.1	0.251
509.1	0.018	583.1	0.262
523.1	0.034	584.6	0.275
535.1	0.049	588.1	0.350
546.1	0.089	591.1	0.374
549.3*	0.124	598.1	0.423
551.1	0.107	602.6	0.469
556.1	0.125	607.1	0.545
558.1†	0.132	613.1	0.707
562.1	0.134	620.1	0.787
568.1	0.1875	629.1	0.933
572.1	0.1928		

$$\Delta H = 20\,400\text{†}$$

* From (97). † From (102); all other values from (95).



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
357.6	0.005	431.6	0.096
390.1	0.012	436.1	0.1335
407.6	0.034	443.6	0.193
423.1	0.059	447.1	0.2125
425.1	0.074	453.6	0.267

NiBr₂·6NH₃(s).—(Continued)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
461.6*	0.509	476.1	0.787
465.6	0.463	479.1	0.932
467.1*	0.621	479.6*	0.913
471.1	0.641	480.6	0.942
472.1*	0.737	483.1	1.033
473.1	0.6995	486.1	1.089
$\Delta H = 61\ 400\ (102)$			

* From (379); all other values from (95).

NiBr₂·6CH₃NH₂(s) = (?) + xCH₃NH₂(g) (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
356.6	0.0559	398.1	0.567
366.6	0.1058	407.1	0.804
376.1	0.183	413.1	1.000 (interp.)
388.1	0.343	417.1	1.139
$\Delta H = 14\ 870x$			

NiBr₂·4C₂H₅NH₂(s) = (?) + xC₂H₅NH₂(g) (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
376.6	0.058	423.1	0.708
386.6	0.145	432.6	1.020
397.6	0.251	437.1	1.251
411.6	0.418	$\Delta H = 15\ 970x$	

NiBr₂·6C₂H₅NH₂(s) = NiBr₂·4C₂H₅NH₂(s) + 2C₂H₅NH₂(g) (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.045	345.6	0.680
310.6	0.107	352.1	0.908
315.1	0.142	354.1	1.000 (extrap.)
326.1	0.263	357.1	1.109
335.6	0.424	363.1	1.441
$\Delta H = 25\ 120$			

NiBr₂·4(CH₃)₂NH(s) = (?) + x(CH₃)₂NH (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
295.1	0.025	337.6	0.724
309.1	0.107	346.1	1.000 (interp.)
312.1	0.153	349.1	1.098
318.6	0.264	354.1	1.335
329.1	0.504	$\Delta H = 12\ 240x$	

NiI₂·2NH₃(s) = NiI₂(s) + 2NH₃(g) (95, 102) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
452.1	0.0047	538.1*	0.132 (extrap.)
460.1	0.0053	549.6	0.167
479.1	0.0125	558.6	0.261
503.1	0.0499	575.1	0.4298
515.1	0.0572	581.6	0.459
519.6	0.0599	595.6	0.7572
526.1	0.0868	$\Delta H = 39\ 360^*$	

* From (102); all other values from (95).

NiI₂·6NH₃(s) = NiI₂·2NH₃(s) + 4NH₃(g) (95, 379) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
443.1	0.111	486.1	0.476
447.1*	0.112	491.1*	0.528
452.1*	0.147	493.1	0.618
455.1	0.164	498.6	0.743
468.1	0.257	507.1	0.947
478.1	0.362	508.6	1.000 (extrap.)
$\Delta H = 63\ 760\ (102)$			

* From (95); all other values from (379).

NiI₂·6CH₃NH₂(s) = (?) + xCH₃NH₂(g) (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
416.6	0.084	469.1	0.758
432.1	0.160	476.1	1.000 (interp.)
441.1	0.245	479.1	1.093
457.6	0.482	485.1	1.326
$\Delta H = 17\ 370x$			

NiI₂·4C₂H₅NH₂(s) = (?) + xC₂H₅NH₂(g) (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
391.6	0.043	444.1	0.763
410.6	0.108	449.1	1.000 (interp.)
418.1	0.178	450.6	1.055
428.6	0.334	454.6	1.189
437.1	0.530	$\Delta H = 16\ 290x$	
Decomposition product			
416.1	0.058	449.1	0.096
431.1	0.076	477.1	0.124

NiI₂·6C₂H₅NH₂(s) = NiI₂·4C₂H₅NH₂(s) + 2C₂H₅NH₂(g) (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
330.1	0.063	368.6	0.734
345.1	0.203	373.6	0.918
357.1	0.430	375.1	1.000 (interp.)
363.6	0.599	380.6	1.275
$\Delta H = 27\ 140$			

NiI₂·4(CH₃)₂NH(s) = (?) + x(CH₃)₂NH(g) (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
345.6	0.382	371.1	1.00 (interp.)
354.1	0.496	373.1	1.087
363.6	0.701	377.6	1.334
$\Delta H = 13\ 220x$			

NiI₂·6(CH₃)₂NH(s) = NiI₂·4(CH₃)₂NH(s) + 2(CH₃)₂NH(g) (393) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.6	0.054	292.6	0.707
276.1	0.132	296.6	0.924
282.6	0.324	298.1	1.000 (interp.)
285.1	0.408	299.1	1.074
$\Delta H = 20\ 780$			

NiI₂·2C₃H₇NH₂(s) = (?) + xC₃H₇NH₂(g) (393) (E)

<i>T</i>	<i>P</i> *	<i>T</i>	<i>P</i> *
327.6	0.021	392.1	0.291
341.6	0.063	407.6	0.391
355.6	0.130	418.6	0.536
374.1	0.107	427.6	0.672

* The curve is abnormally flat. At higher pressures, the substance contains a different amount of C₃H₇NH₂.**NiI₂·1 or 1½ (CH₃)₃N(s) = (?) + x(CH₃)₃N(g) (393) (E)**

<i>T</i>	<i>P</i> *	<i>T</i>	<i>P</i> *
316.1	0.036	368.1	0.220
333.1	0.068	383.1†	0.309
354.1	0.147	395.6	0.391

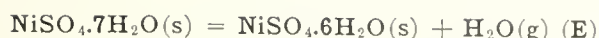
* The curve is abnormally flat. † The substance melts at 383.1°K.

Ni(IO₃)₂·5NH₃(s) = (?) + xNH₃(g) (391) (E)

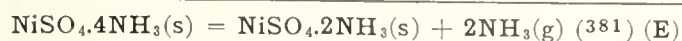
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
326.1	0.236	350.1	0.882
338.1	0.480	352.6	1.191

NiSO₄·H₂O(s) = NiSO₄(s) + H₂O(g) (848) (E)

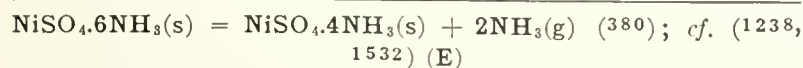
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.0138	333.1	0.211
293.1	0.0189	348.1	0.355



$P_{298.1} = 0.02722$ (1335); according to (848), the vapor pressure of the compound differs very little from that of the saturated solution



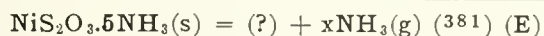
T	P	T	P
409.1	0.116	443.6	0.724
424.6	0.188	448.1	0.943
436.6	0.461	451.6	1.000 (extrap.)
$\Delta H = 32 \text{ 880}$			



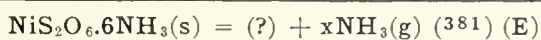
T	P	T	P
373.6	0.224	404.6	0.846
384.1	0.338	407.1	0.989
395.6	0.580		$\Delta H = 29 \text{ 340}$

Ephraim (380) found for a preparation after 1½ years the following pressures:

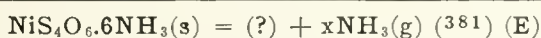
T	P	T	P
393.1	0.387	408.1	0.691
396.6	0.445	414.4	0.895
403.1	0.582	417.6	1.065



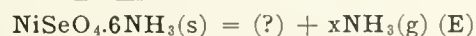
T	P	T	P
364.6	0.105	410.1	0.789
382.6	0.221	415.1	0.941
394.6	0.411	416.6	1.000 (extrap.)
405.6	0.671		$\Delta H = 15 \text{ 000x}$



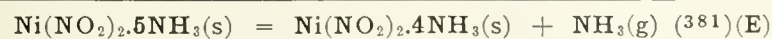
T	P	T	P
389.1	0.092	442.1	0.566
403.6	0.187	451.6	0.732
421.1	0.322	455.6	0.850
433.1	0.447	459.6	1.000 (extrap.)
$\Delta H = 16 \text{ 800x}$			



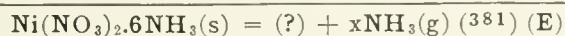
T	P	T	P
349.1	0.079	399.1	0.776
369.6	0.208	403.1	0.888
378.6	0.333	404.6	0.920
389.6	0.579	406.6	1.000 (extrap.)
$\Delta H = 14 \text{ 700x}$			



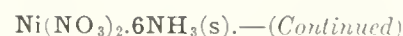
$$P_{441.1} = 1.00 \text{ (397)}$$



T	P	T	P
320.6	0.079	361.6	0.438
335.1	0.164	372.6	0.611
342.1	0.217	379.6	0.757
348.1	0.274	388.1	0.953
358.6	0.388	389.6	1.000 (extrap.)
$\Delta H = 13 \text{ 800}$			

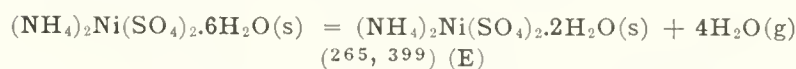


T	P	T	P
388.1	0.087	420.6	0.254
395.6	0.118*	426.6	0.308*
408.6	0.163	432.6	0.366
413.1	0.217*	441.6	0.499*



T	P	T	P
444.6	0.542	458.6	0.833*
450.1	0.647*	464.1	0.996*
453.1	0.674		$\Delta H = 17 \text{ 000x}$

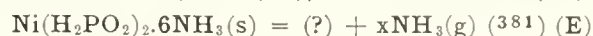
* Substance contains somewhat less than 6 moles NH_3 .



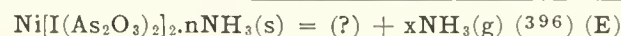
$$\Delta H = 61 \text{ 600; } \log P = -0.511 + 2 \text{ 437}/T - 946 \text{ 400}/T^2$$

T	P	T	P
306.6	0.0021	337.2	0.0245*
314.0	0.0045*	341.1	0.0320
316.3	0.0054	345.9	0.0420
321.3	0.0075*	393.1†	0.0537
326.8	0.0121	403.1†	0.0737

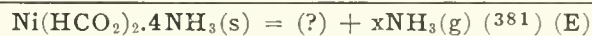
* Measured on cooling. † From (399); all other values from (265).



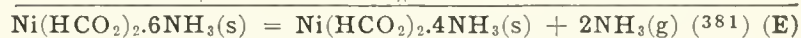
T	P	T	P
313.1	0.053	335.1	0.243
324.1	0.125	368.1	1.000 (extrap.)
330.6	0.192		$\Delta H = 13 \text{ 300x}$



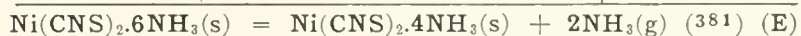
Moles NH_3	T at which $P = 1$	Moles NH_3	T at which $P = 1$
16.1	259.1	10.3	339.1
14.2	291.1	9.9	345.1
13.9	331.1	1.2	350.1



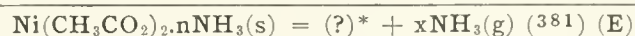
T	P	T	P
333.1	0.012	404.6	0.493
375.6	0.079	418.1	1.000 (extrap.)
391.6	0.192		$\Delta H = 15 \text{ 100x}$



T	P	T	P
273.1	0.164	293.1	0.479
283.1	0.287	297.1	0.592
289.1	0.403	304.1	0.816
292.1	0.467	308.1	0.980
$\Delta H = 21 \text{ 600}$			



T	P	T	P
318.1	0.132	351.1	0.761
330.1	0.263	357.1	0.974
340.1	0.441	357.6	1.000 (extrap.)
346.6	0.605		$\Delta H = 21 \text{ 600}$



T	P	T	P
Compound containing ca. 5½ moles NH_3			
273.1	0.158	302.6	0.868
282.1	0.305	304.1	0.921
294.6	0.600	306.1	0.968
299.6	0.757		
Compound containing ca. 5 moles NH_3			
293.1	0.026	346.6	0.579
304.1	0.079	350.1	0.687
316.1	0.164	352.6	0.803
326.6	0.245	353.1	0.838
336.1	0.349	357.1	1.026
339.6	0.428		

* Forms solid solution with NH_3 .

$\text{Ni}(\text{C}_6\text{H}_5\text{CO}_2)_2$ (Solid solution with *ca.* $7\frac{1}{2}$ NH_3) =
 $\text{Ni}(\text{C}_6\text{H}_5\text{CO}_2)_2.6\text{NH}_3(\text{s}) + x\text{NH}_3(\text{g})$ (383)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.351	308.1	0.804
298.1	0.496	311.1	0.947
303.1	0.658	312.1	1.000

$\text{Ni}(\text{C}_6\text{H}_5\text{CO}_2)_2.8\text{NH}_3(\text{s})$ = (Solid solution with *ca.* $7\frac{1}{2}$ NH_3)
 $+ x\text{NH}_3(\text{g})$ (383)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
257.1	0.305	267.1	0.625
260.1	0.364	271.1	0.938
262.6	0.447	271.6	1.000

$\text{Ni}(\text{C}_6\text{H}_5\text{SO}_3)_2.6\text{NH}_3(\text{s})$ = (?) + $x\text{NH}_3(\text{g})$ (383) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
396.	0.318	417.6	0.953
413.6	0.750	418.6	1.000

$\text{Ni } o\text{-naphthoylbenzoate}.8\text{NH}_3(\text{s})$ = $\text{Ni } o\text{-naphthoylbenzoate}.6\text{NH}_3(\text{s}) + 2\text{NH}_3(\text{g})$ (383) (E)

<i>T</i>	<i>P*</i>	<i>T</i>	<i>P*</i>
266.1	0.192	281.6	0.487
268.1	0.237	285.1	0.632
272.1	0.309	289.1	0.855
277.1	0.408	291.1	0.968

* Since solid solutions result from the decomposition, the pressure of the pure octamine is somewhat higher than here found.

$\text{Ni dibromonaphthalene-2-sulfonate}.6\text{NH}_3(\text{s})$ = (?) + $x\text{NH}_3(\text{g})$ (E)

P = 1.00 at *ca.* 423°K (383)

$\text{Ni naphthalene-2-sulfonate}.8\text{NH}_3(\text{s})$ = $\text{Ni naphthalene-2-sulfonate}.6\text{NH}_3(\text{s}) + 2\text{NH}_3(\text{g})$ (383) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
278.1	0.303	298.1	0.980
286.1	0.493	299.1	1.019
292.1	0.704		

$\text{Ni dibromonaphthalene-2-sulfonate}.8\text{NH}_3(\text{s})$ = Solid soln. up to hexamine + $\text{NH}_3(\text{g})$ (E)

P = 1.00 at *ca.* 273.1°K (383)

$\text{Ni naphthalate}.6\text{NH}_3(\text{s})$ = $\text{Ni naphthalate}.4\text{NH}_3(\text{s}) + 2\text{NH}_3(\text{g})$ (E)
P = 1.00 below 273.1°K (383)

$\text{Ni}(\text{NH}_2\text{C}_6\text{H}_4\text{SO}_3)_2.8\text{NH}_3(\text{s})$ = (?) + $x\text{NH}_3(\text{g})$ (E)

Solid solutions result upon decomposition. The compound exerts a pressure of 1.00 atm. several degrees below 273.1°K (383)

$\text{Ni}[\text{Co}(\text{NO}_2)_4(\text{NH}_3)_2]_2.8\text{NH}_3(\text{s})$ = (?) + $x\text{NH}_3(\text{g})$ (E)

The pressure of NH_3 above 273°K is considerable. On heating to 373.1°K, the compound still contains 6 moles of NH_3 (396)

$\text{Ni}[\text{Co}(\text{C}_2\text{O}_4)(\text{NO}_2)_2(\text{NH}_3)_2]_2.8\text{NH}_3(\text{s})$ = (?) + $x\text{NH}_3(\text{g})$ (E)

The compound is stable at room temperature. At about 260°K it contains an additional 2 moles of NH_3 ; at 253°K still 2 more moles of NH_3 (396)

Cr, Chromium

$\text{Cr}(\text{s}) = \text{Cr}^{+++}$; $E_{291.1}^0 = -0.29$ (701)

$\text{Cr}^{+++} + \text{H}_2\text{O}(\text{l}) = \text{Cr}(\text{OH})^{++} + \text{H}^+$ (115); *cf.* (1155)

<i>T</i>	<i>c</i> (CrCl ₃)	<i>c</i> (KCl)	<i>K_c</i>
290.1	0.0000625		0.99
290.1	.0000625	0.1	.41
291.0	.0000625		.88
291.0	.0000625	0.1	.44
273.1	.0003333		.27
273.1	.0003333	0.1	.156
290.1	.0003333		.83
290.1	.0003333	0.1	.48

$\text{Cr}^{+++} + \text{H}_2\text{O}(\text{l})$.—(Continued)

<i>T</i>	<i>c</i> (CrCl ₃)	<i>c</i> (KCl)	<i>K_c</i>
290.1	0.0003333	0.2	0.30
291.1	.0003333		.88
291.1	.0003333	0.1	.51
291.1	.0003333	0.2	.32
290.1	.00100		.61
290.1	.00100	0.1	.45
292.1	.00100		.82
291.1	.0100		.79
291.1	.0100		.84

$\text{HCrO}_4^- = \text{CrO}_4^{--} + \text{H}^+$

$K_{291.1} = 3.7 \times 10^{-7}$ (72)

$\text{Cr}(\text{OH})^{++} + \text{H}_2\text{O}(\text{l}) = \text{Cr}(\text{OH})_2^+ + \text{H}^+$ (115)

<i>T</i>	<i>c</i> (CrCl ₃)	<i>c</i> (KCl)	<i>K_c</i>
290.1	0.0000625	0.1	0.0062
273.1	.000333	0.1	.0025
290.1	.000333	0.1	.0060
290.1	.000333	0.2	.0065
290.1	.001000		.0059
290.1	.001000	0.1	.0096

$\text{Cr}(\text{OH})_2^+ + \text{H}_2\text{O}(\text{l}) = \text{Cr}(\text{OH})_3(\text{s}) + \text{H}^+$ (115)

$\text{Cr}(\text{OH})_3(\text{s}) + 3\text{OH}^- = \text{CrO}_3^{--} + 3\text{H}_2\text{O}(\text{l})$ (449.5, 1023.5, 1024.5)

$\text{Cr}(\text{OH})_3(\text{s}) = \text{Cr}(\text{OH})_2^+ + \text{OH}^-$

$K = 1.5 \times 10^{-16}$ (701); *cf.* (115)

$\text{CrCl}_2.3\text{NH}_3(\text{s})$ = (?) (Decomposes without formation of solid soln.) + $x\text{NH}_3(\text{g})$ (395) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
317.1	0.059	365.1	0.813
332.6	0.127	367.6	0.901
345.1	0.261	368.1	0.961
359.1	0.570		$\Delta H = 13 \text{ } 100x$

$\text{CrCl}_2.6\text{NH}_3(\text{s})$ = (?) (Solid solution on decomposition) + $x\text{NH}_3(\text{g})$ (E)

*P*_{313.1} = 1.00; $\Delta H = 11 \text{ } 100x$ (395)

$[\text{CrCl}_2(\text{H}_2\text{O})_4]^+$ (green) + $3\text{H}_2\text{O}(\text{l}) = [\text{Cr}(\text{H}_2\text{O})_6\text{OH}]^{++} + 2\text{Cl}^- + \text{H}^+$

$K_{298.1} = 1.9 \times 10^{-4}$ (811); *cf.* (114, 115, 328, 809)

$\text{CrBr}_2.6\text{NH}_3(\text{s})$ = (?) + $x\text{NH}_3(\text{g})$ (E)

Dissociation temperature higher than that of $\text{CrCl}_2.6\text{NH}_3$ (395)

$(\text{NH}_2\text{OH})\text{Cr}(\text{SO}_4)_2.12\text{H}_2\text{O}(\text{s})$ = (?) + $x\text{H}_2\text{O}(\text{g})$ (1026) (E)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
303.1	0.011	334.1	0.150
308.1	0.018	334.6	0.1503
312.1	0.026	338.1	0.184
318.1	0.047	342.1	0.228
328.1	0.103	345.1	0.263

$\text{NH}_4\text{Cr}(\text{SO}_4)_2.12\text{H}_2\text{O}(\text{s})$ = (?) + $x\text{H}_2\text{O}(\text{g})$ (399) (E)

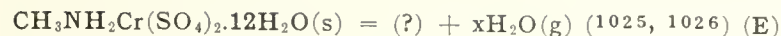
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.1	0.053	353.1	0.321
333.6	0.105	359.1	0.429
345.1	0.213		

$\text{Cr}(\text{NH}_3)_6\text{-salts}$; anions: Br, Cl, I, NO_3 (NO_3 , Br), SO_4 , and PO_4 (395) (E)

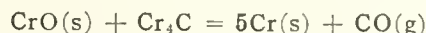
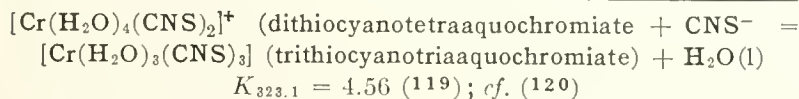
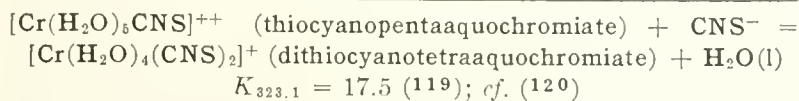
The results are not easy to interpret. The determination of the vapor pressure was made difficult through the slowness of pressure equilibrium, and through the tendency toward further decomposition

$\text{Cr}(\text{H}_2\text{O})_6^{+++}$ (hexaquochromiate) + $\text{CNS}^- = \text{Cr}(\text{H}_2\text{O})_5\text{CNS}^{++}$ (thiocyanopentaquochromiate) + $\text{H}_2\text{O}(\text{l})$

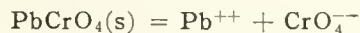
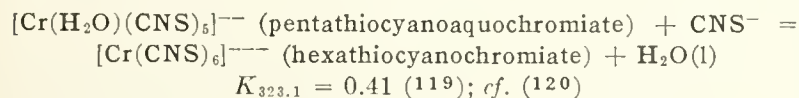
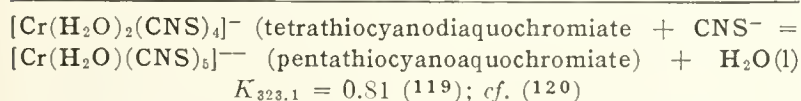
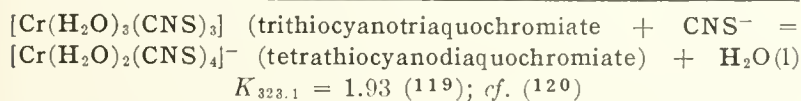
$K_{323.1} = 328$ (119); *cf.* (120)



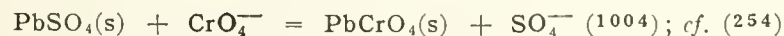
T	P	T	P
308.1	0.007	341.1	0.155
315.1	0.018	342.1	0.161
323.1	0.042	345.6	0.203
333.1	0.095	348.1	0.236
336.6	0.121	351.6	0.286
340.1	0.147		



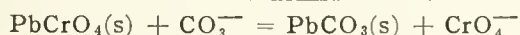
$$P_{1555} = 0.0058 - 0.0082; P_{1612} = 0.0121 \text{ (1362, 1366)}$$



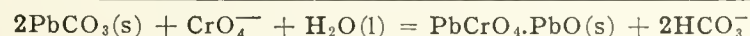
$$K_{291.1} = 1.77 \times 10^{-14} \text{ (72)}$$



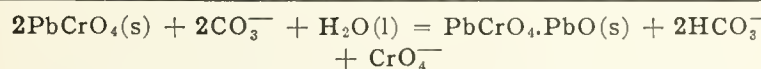
T	K_c	T	K_c
291.1	0.000277	341.1	0.000440
311.1	.000365	371.6	.000505



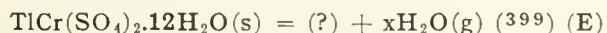
$$K_{291.1} = \text{ca. } 0.2 \text{ (36)}$$



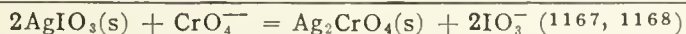
$$K_{291.1} = \text{ca. } 1.95 \text{ (36)}$$



$$K_{291.1} = \text{ca. } 0.057 \text{ (36)}$$

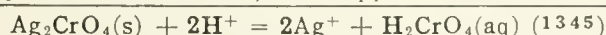


T	P	T	P
306.1	0.011	353.1	0.349
314.1	0.028	360.6	0.518
323.1	0.058	367.1	0.667
334.1	0.130	373.1	0.832
341.1	0.204	375.1	0.884
346.1	0.262		



T	$c(\text{KIO}_3)$	$c(\text{K}_2\text{CrO}_4)$	$c(\text{KNO}_3)$	μ_c	K_c
293.1	0.007	0.0865	0.02	0.2865	0.000567

Solid phases not identified; value approximate.

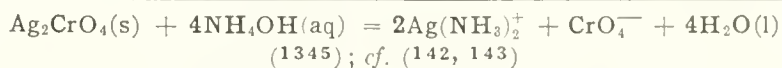


$c(\text{Ag}^+) = 2c(\Sigma\text{Cr}); c(\Sigma\text{Cr}) = c(\text{H}_2\text{CrO}_4(\text{aq})) + 2c(\text{H}_2\text{Cr}_2\text{O}_7(\text{aq})) + c(\text{HCrO}_4^-) + 2c(\text{Cr}_2\text{O}_7^{--}); c(\text{HNO}_3(\text{aq})) = c(\text{HNO}_3(\text{aq}))$ to which Ag_2CrO_4 was added.

$c(\text{HNO}_3)$	$c(\Sigma\text{Cr})$	$c(\text{HNO}_3)$	$c(\Sigma\text{Cr})$
0.01	0.0031575	0.025	0.004567
.015	.00373	.03	.005200
.02	.004178	.04	.005804



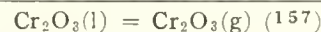
$c(\text{HNO}_3)$	$c(\Sigma\text{Cr})$	$c(\text{HNO}_3)$	$c(\Sigma\text{Cr})$
0.05	0.006380	0.07	0.007333
.06	.006833	.075	.007425



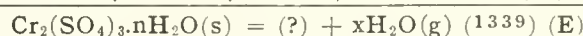
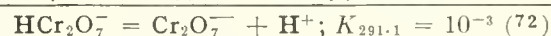
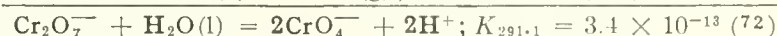
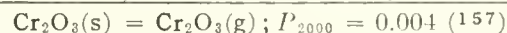
$$\frac{1}{3} \log (1/K) \text{ at } 298.1^\circ\text{K} = -1.630 \pm 0.010; \Delta F_{298.1}^0 = -6.674$$

$c(\text{Total NH}_4\text{OH})$	$c(\text{CrO}_4^{--})$	$c(\text{Free NH}_4\text{OH})$	$\frac{1}{3} \log (1/K_c')$	$\mu_c^{1/2}$
0.01	0.002	0.00200	-1.7025	0.0775
.01	.002005	.00198	-1.7093	.0775
.02*	.004170	.00332	-1.7280	.1119
.04	.008585	.00566	-1.7328	.1605
.04	.008625	.00550	-1.7513	.1609
.08*	.01758	.00968	-1.8721	.2297

* Two experiments.



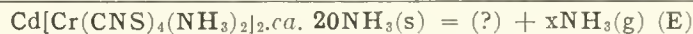
T	P	ΔH
2 500-3 000	1	63 000-77 000



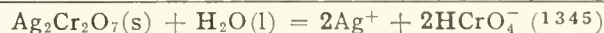
T	Pressures for n =				
	17.25	16.55	15.77	15.05	14.78
298.7	0.0263		0.0145	0.0146	
302.4	0.0321	0.0229	0.0184	0.0182	0.0168
307.1	0.0414	0.0318	0.0251	0.0242	0.0228
311.6	0.0514	0.0420	0.0328	0.0309	
313.5	0.0571		0.0364	0.0345	



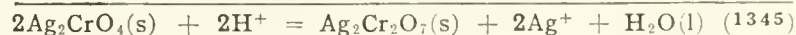
$$P = 1 \text{ atm. at room temperature (396)}$$



$$P = 1 \text{ atm. at ca. } 253.1^\circ\text{K} \text{ (396)}$$



$c(\Sigma\text{H})$	$c(\Sigma\text{Cr})$	$c(\Sigma\text{Ag})$
0.06	0.01110	0.01110
0.08	0.01110	0.01110
0.08	0.006623	0.016623

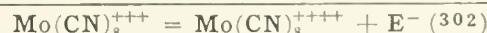
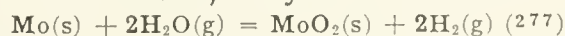


$c(\Sigma\text{H})$	$c(\Sigma\text{Cr})$	$c(\Sigma\text{Ag})$
0.0	0.03220	0.005390
.01	.02506	.006131
.02	.02021	.007148
.04	.01359	.009524
.08	.00726	.01546
.10	.005647	.01901
.13	.004294	.02389
.14	.003498	.02563



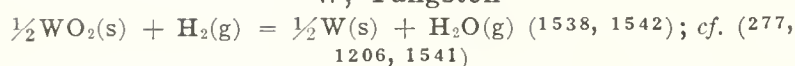
n at $373.1^\circ\text{K} = 4$, at room temperature = 9; on evaporation of the solution, in liquid NH_3 , n = 14 (396)

Mo, Molybdenum

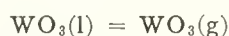


$$P_{389.1} = 1.00 \text{ (397)}$$

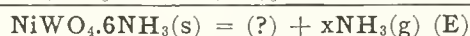
W, Tungsten



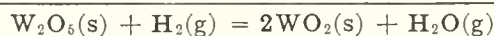
<i>T</i>	<i>K</i>	<i>T</i>	<i>K</i>
1 007 (1542)	0.45	1 214 (1542)	0.99
1 073 (1538)	.53	1 223 (1538)	1.00
1 101 (1542)	.65	1 273 (1538)	1.16
1 138 (1542)	.75	1 309 (1542)	1.29
1 173 (1538)	.82		



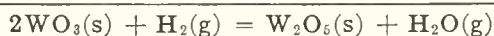
$$P_{2000} = 1; \Delta H = 49\,000 \text{ (157); cf. (824)}$$



$$P_{393.1} = 1.00 \text{ (397)}$$

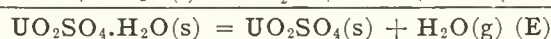
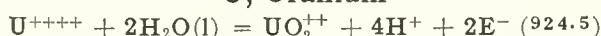


$$K_{1073} = 5.0 \text{ (1538); cf. (277)}$$

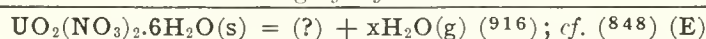


$$K_{1073} = 15 \text{ (1538); cf. (1206)}$$

U, Uranium



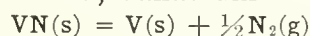
$P_{293.1} = 0.0026 \text{ (848); Lescœur (848) also gives some data for a more highly hydrated salt}$



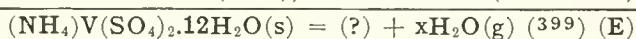
Maximum loss in weight at 298.1°K over $\text{H}_2\text{SO}_4(\text{aq})$

$P_{\text{H}_2\text{O}}$	% Loss H_2O	$P_{\text{H}_2\text{O}}$	% Loss H_2O
0.02839	Deliquescent	0.00580	2.94
0.02579	Deliquescent	0.00230	2.99
0.02320	0.0	0.00074	3.97
0.01769	0.0	0.0003	4.01
0.01161	0.0	0.00	4.01

V, Vanadium

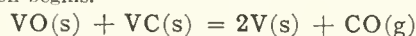


$$P_{1476} = >0.0003 \text{ (1364); } P_{1544} = 0.0020 \text{ (1365, 1366)}$$



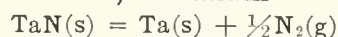
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.1	0.049	353.1	0.309
333.1	0.097	363.1*	0.567
343.1	0.184		

* Decomposition begins.

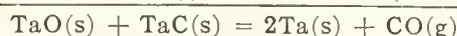


$$P_{1613} = 0.0016 - 0.0022; P_{2100} = 1.00 \text{ (extrap.); } \Delta H = 80\,875 \text{ (1366)}$$

Ta, Tantalum

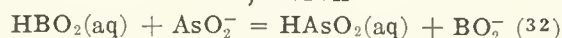


$$P_{1443} = 0.0006 \text{ (1364); } P_{1581} = 0.0013 \text{ (1365, 1366)}$$



$$P_{1543} = 0.00013 \text{ (1366)}$$

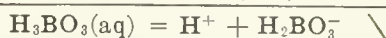
B, Boron



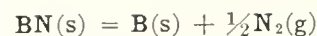
$T = 298.1^\circ\text{K}$; $c_{(\text{HNO}_3)} = 0.8952$; $\text{H}_2\text{BO}_3(\text{s})$ present; for the range $c_{(\text{HAsO}_2)} = 0.0626 - 0.2230$; $c_{(\Sigma\text{As})} = 0.0856 - 0.2620$, $c_{(\Sigma\text{Na})} = 0.3694 - 0.0522$, $c_{(\text{AsO}_2^-)} = 0.0084 - 0.0457$, $c_{(\text{HAsO}_4^-)} = 0.0019 - 0.0218$, K_c (average) = 0.83 with range 0.94 - 0.67



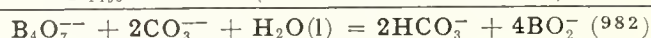
$$K_{273.1} = 0.024 \text{ (983)}$$



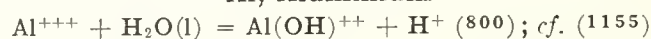
$$K_{291.1} = 5.7 \times 10^{-10} \text{ (982); } K_{298.1} = 8 \times 10^{-10} \text{ (1162); } = 5.78 \times 10^{-10} \text{ (177)}$$



$$P_{1495} = 0.0116 \text{ (1147.5, 1364, 1365, 1366)}$$

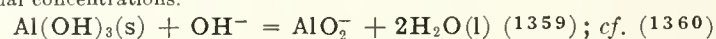


Al, Aluminium

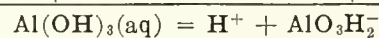


<i>c</i> (AlCl_3)	<i>c</i> (NaCl)	% Hydrolysis	
		358.6°K	373.1°K
0.00065		34.09	47.68
0.0026		16.05	24.16
0.0104		6.57	9.92
0.00065	0.125	15.4	17.4
0.0026	0.0312	8.9	
0.0026	0.125	18.2	18.7
0.0104	0.0312	0.2	
0.0104	0.125	6.8	5.1
$c_{(\text{Al}(\text{NO}_3)_3)}$			
0.0026		15.36	23.98
$c_{(\text{Al}_2(\text{SO}_4)_3)^*}$			
0.0001625			48.22
(0.000325)			23.17
0.0065 (0.0013)		8.39	9.64
0.0026 (0.0052)			5.115
0.0104 (0.0208)			

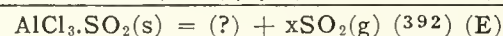
* The concentrations given by (800) for $\text{Al}_2(\text{SO}_4)_3$ are probably twice the actual concentrations.



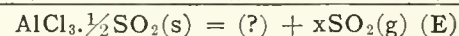
<i>T</i>	<i>c</i> (NaOH)	<i>c</i> (AlO_2^-)
Room.....	0.6414	0.172



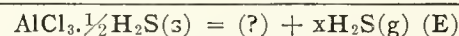
$$K > 10^{-10} \text{ (1360); cf. (328, 1550, 1551)}$$



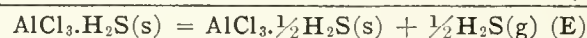
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.026	311.6	0.138
282.6	0.053	335.1	0.211
293.6	0.086	373.1	0.329



$$P_{611.1} = 1.00 \text{ (62)}$$



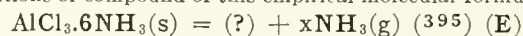
$$P_{323.1} = 1.00 \text{ calculated from heat of formation (62)}$$



$$P_{228.1} = 1; \text{calculated from heat of formation (62)}$$

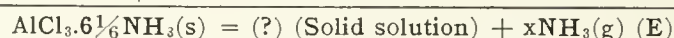
$\text{AlCl}_3 \cdot 1\frac{1}{6}\text{NH}_3^* \text{ (E)}$	$\text{AlCl}_3 \cdot 3\frac{1}{6}\text{NH}_3^* \text{ (E)}$	$\text{AlCl}_3 \cdot 5\frac{1}{6}\text{NH}_3^* \text{ (E)}$
$P_{1041.1} = 1.00 \text{ (62)}$	$P_{767.1} = 1.00 \text{ (62)}$	$P_{607.1} = 1.00 \text{ (62)}$

* Solid solutions of compound of this empirical molecular formula.

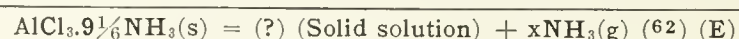


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
320.1	0.025	396.6	0.682
342.6	0.0513	401.1	0.908
370.6	0.184	402.6	1.000 (extrap.)

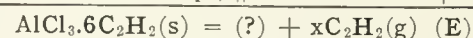
$$\Delta H = 14\,500x$$



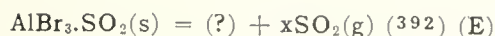
$P_{359.5} = 1.000 \text{ (62); Ephraim and Millman (395) find for } \text{AlCl}_3 \cdot 6\text{NH}_3 \text{ saturated with } \text{NH}_3 \text{ at room temperatures, a pressure of } 0.164 \text{ atm. at } T = 322.1$



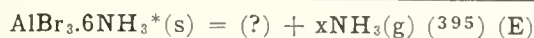
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
236.1	0.249	262.4	1.287
250.8	0.633	273.1	2.355
258.5	1.000 (interp.)		



$$P_{213.1} = 1.00 \text{ calculated from heat of formation (62)}$$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
289.1	0.014	348.1	0.283
325.6	0.161	360.6	0.384



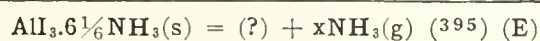
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
421.1	0.113	484.1	0.579
444.6	0.155	501.1	1.000 (interp.)
469.6	0.321	502.1	1.037

$\Delta H = 18 \text{ 400x}$

* The hexammine absorbs 2.5 % more NH_3 at room temperature. It then shows a pressure of 0.066 atm. at $T = 273.1^\circ\text{K}$.

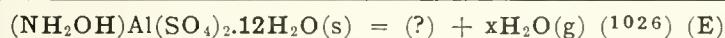
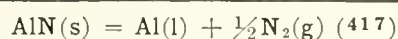


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
290.6	0.013	361.1	0.279
313.1	0.071	363.1	0.349
327.1	0.129		

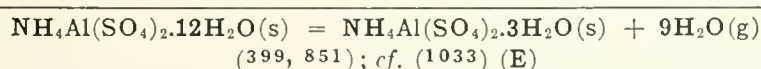
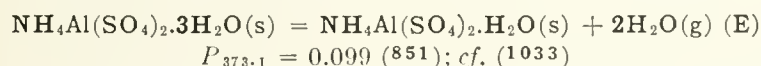


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
292.6	0.039	352.6	1.00 (interp.)
325.6	0.212	353.6	1.054

$\Delta H = 12 \text{ 500x}$

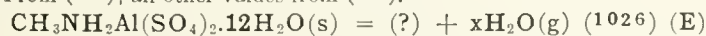


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
300.1	0.008	333.1	0.145
305.1	0.013	335.1	0.1455
308.1	0.016	336.1	0.149
313.1	0.028	338.1	0.168
318.1	0.045	343.1	0.226
328.1	0.101	348.1	0.297

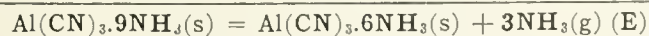
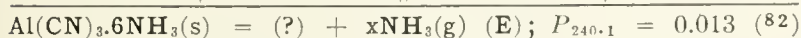


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.1	0.028	351.9*	0.193
333.1*	0.061	352.1	0.212
333.1	0.064	357.1	0.288
342.4*	0.108	361.5*	0.421
343.1	0.114		

* From (851); all other values from (399).



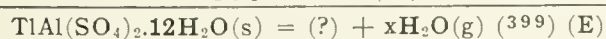
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
313.1	0.0164	343.1	0.166
323.1	0.0401	345.1	0.184
328.1	0.061	348.6	0.216
333.1	0.088		



$$P_{240.1} = 0.132 \quad (82)$$



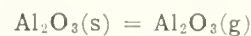
$$P_{240.1} = 0.605 \quad (82)$$



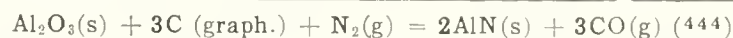
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
324.1	0.030	353.1	0.241
333.1	0.066	359.1	0.368
343.1	0.130	362.1	0.476



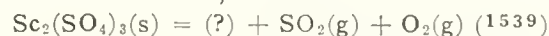
$$P_{2000} = < 10^{-50} \quad (157)$$



$$P_{2000} = 0.035 \quad (157); P_{2500} = 1.000 \quad (1279)$$

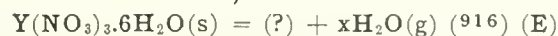


Sc, Scandium



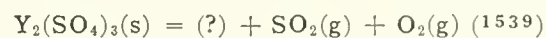
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 073	0.039	1 173	0.375
1 093	0.063	1 213	0.820
1 113	0.101	At 1173°K, $P_{\text{SO}_3} = 0.014$	
1 133	0.164		

Y, Yttrium

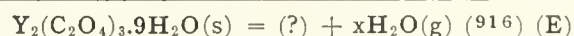


Maximum loss in weight at 298.1°K over $\text{H}_2\text{SO}_4(\text{aq})$

$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.02839	Deliquescent	0.00580	1.02
0.02579	Deliquescent	0.00230	1.03
0.02320	Deliquescent	0.00074	3.01
0.01769	Deliquescent	0.0003	3.01
0.01161	0.00	0.00	3.03



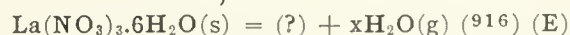
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 113	0.018	1 253	0.325
1 133	.029	1 273	.449
1 173	.072	1 293	.618
1 213	.162	At 1173°K, $P_{\text{SO}_3} = 0.004$	



Maximum loss in weight at 298.1°K over $\text{H}_2\text{SO}_4(\text{aq})$

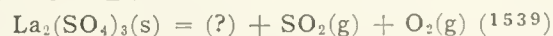
$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.02839	0.0	0.00580	0.50
0.02579	0.06	0.00230	3.96
0.02320	0.16	0.00074	6.21
0.01769	0.26	0.0003	6.86
0.01161	0.34	0.00	7.05

La, Lanthanum

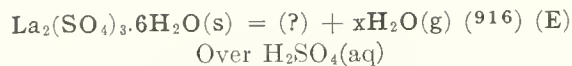


Over $\text{H}_2\text{SO}_4(\text{aq})$

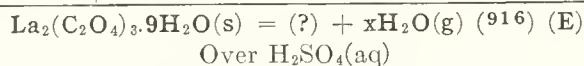
$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.02839	Deliquescent	0.00580	0.00
0.02579	Deliquescent	0.00230	2.01
0.02319	Deliquescent	0.00074	1.98
0.01769	0.0	0.0003	4.92
0.0116	0.0	0.000	4.98



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 113	0.013	1 253	0.258
1 133	.021	1 273	.355
1 173	.054	1 293	.487
1 213	.130	At 1173°K, $P_{\text{SO}_3} = 0.0026$	

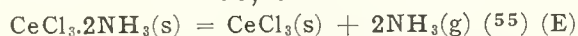


$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.02839	0.0	0.00580	0.0
0.02579	0.0	0.00230	0.0
0.02319	0.0	0.00074	3.04
0.01769	0.0	0.0003	5.96
0.0116	0.0	0.000	6.03

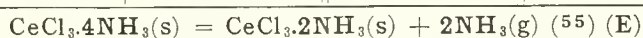


$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.02839	0.02	0.00580	0.41
0.02579	0.08	0.00230	0.57
0.02319	0.12	0.00074	3.93
0.01769	0.18	0.0003	6.89
0.0116	0.26	0.000	6.95

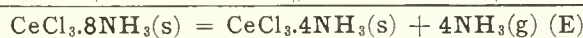
Ce, Cerium



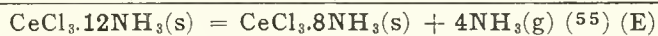
T	P	T	P
363.1	0.545	378.1	1.594
373.1	1.089		



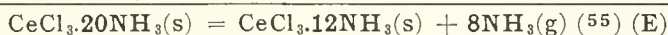
T	P	T	P
323.1	0.295	343.6	1.209
333.1	0.645	348.1	1.695
338.1	0.858		



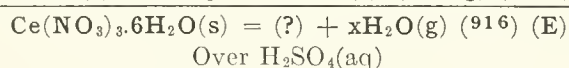
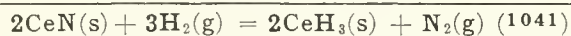
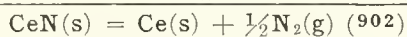
T	P	T	P
273.1	0.345	300.1	1.421
282.6	0.654	303.1	1.718
292.1	1.053		



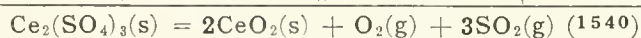
T	P	T	P
243.1	0.432	262.1	1.160
255.1	0.836	273.1	2.068
258.1	0.934		



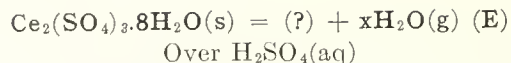
T	P	T	P
204.1	0.087	247.1	1.263
233.1	0.734	256.6	2.006
238.1	0.892	273.1	4.142



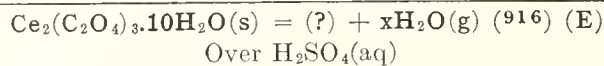
$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.01161	0	0.00074	2.01
0.00580	0	0.00026	4.89
0.00230	2.01	0.000	5.05



T	P	P_{SO_3}
973	0.013	
1 053	.066	
1 133	.339	0.030
1 173	.671	.062
1 193	.982	

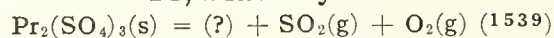


$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.01161	2.99	0.00074	4.00
0.00580	2.99	0.00026	5.98
0.00230	3.91	0.0000	5.98



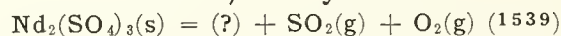
$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.02838	0.06	0.00580	0.91
0.02580	0.15	0.00230	1.20
0.02319	0.27	0.00074	4.35
0.01769	0.36	0.00026	9.29
0.01161	0.60	0.0000	9.29

Pr, Praseodymium



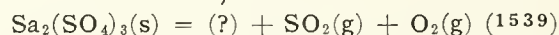
T	P	T	P
1 093	0.024	1 253	0.539
1 113	.037	1 273	.742
1 133	.057	1 293	1.026
1 173	.118	At 1173°K, $P_{\text{SO}_3} = 0.0072$	
1 213	.270		

Nd, Neodymium



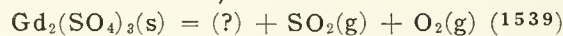
T	P	T	P
1 073	0.018	1 213	0.313
1 093	.028	1 253	.618
1 113	.045	1 273	.855
1 133	.067	At 1173°K, $P_{\text{SO}_3} = 0.008$	
1 173	.145		

Sa, Samarium



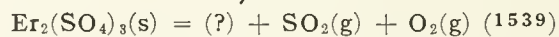
T	P	T	P
1 073	0.025	1 173	0.168
1 093	.038	1 213	.401
1 113	.058	1 253	.816
1 133	.076	At 1173°K, $P_{\text{SO}_3} = 0.011$	

Gd, Gadolinium

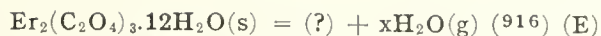


T	P	T	P
1 073	0.021	1 213	0.355
1 093	.033	1 253	.705
1 113	.051	1 273	.971
1 133	.076	At 1173°K, $P_{\text{SO}_3} = 0.009$	
1 173	.168		

Er, Erbium



T	P	T	P
1 113	0.030	1 253	0.454
1 133	.046	1 273	.632
1 173	.107	1 293	.875
1 213	.233	At 1273°K, $P_{\text{SO}_3} = 0.007$	

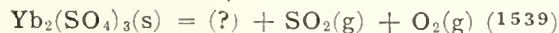


Maximum loss in weight at 298.1°K over $\text{H}_2\text{SO}_4(\text{aq})$ of following strengths:

% H_2SO_4	Loss H_2O , Moles*	% H_2SO_4	Loss H_2O , Moles*
10	0.0	60	0.65
20	0.11	70	4.43
30	0.28	80	6.52
40	0.44	90	6.59
50	0.56	97	7.11

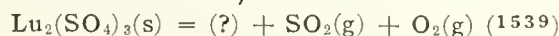
* The loss of water takes place continuously.

Yb, Ytterbium



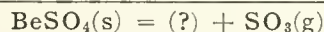
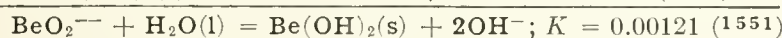
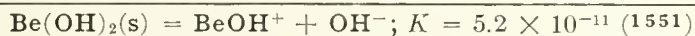
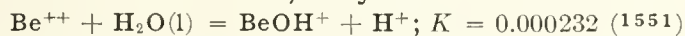
T	P	T	P
1 113	0.025	1 253	0.395
1 133	.039	1 273	.553
1 173	.091	1 293	.743
1 213	.197	At 1273°K, $P_{\text{SO}_3} = 0.005$	

Lu, Lutecium

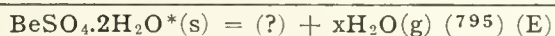


T	P	T	P
1 113	0.022	1 253	0.361
1 133	.034	1 273	.503
1 173	.082	1 293	.684
1 213	.179	At 1273°K, $P_{\text{SO}_3} = 0.0046$	

Be, Beryllium

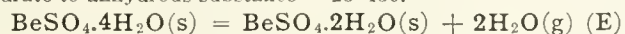


$$\log P_{\text{SO}_3} = -14.907/T - 14.10 \log T + 55.09 \quad (951)$$



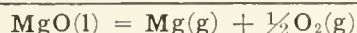
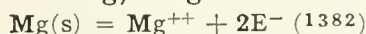
Moles H_2O content	T	P	Moles H_2O content	T	P
1.87	438.1	0.0149	0.41	534.1	0.0237
1.76	454.1	0.0112	0.14	555.1	0.0238
1.51	473.1	0.0220	0.09	573.1	0.00062
1.18	484.1	0.0255	0.06	583.1	0.00062
0.88	501.1	0.0254	0.04	628.1	0.0253
0.66	508.1	0.0193	0.02	663.1	0.0237

* ΔH for decomposition to monohydrate = 21 220; ΔH for decomposition of monohydrate to anhydrous substance = 23 430.

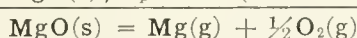
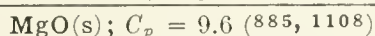


$$P_{387.1} = 0.024; \Delta H = 34\,500 \quad (795)$$

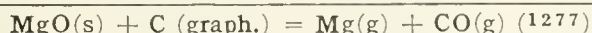
Mg, Magnesium



At 3000°K, $P_{\text{O}_2} = 0.3 \quad (157)$



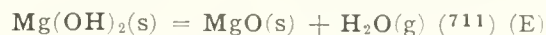
At 2000°K, $P_{\text{O}_2} = 0.000008 \quad (157)$



$P_{2000} = 0.0004 \quad (157)$

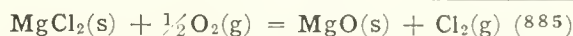
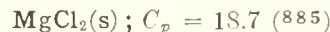


In MgCl_2 at 373.1°K, $c_{(\text{MgCl}_2)} = 0.0625$; % hydrolysis = 0.00266 (800)

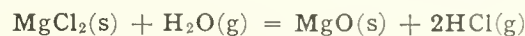


T	P	T	P
308.1	0.010	358.1	0.172
309.1	0.013	359.1	0.196*
317.1	0.0229*	360.1	0.211
323.1	0.034	367.1	0.272
326.1	0.0414*	373.1	0.308*
335.1	0.064	375.1	0.321
336.1	0.072*	391.1	0.467*
339.1	0.088	395.1	0.521
347.1	0.121	420.1	0.692*
352.1	0.149	431.1	0.770
353.1	0.164	444.1	0.836

* Interpolated.



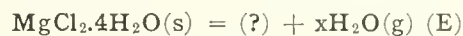
$$\Delta F^0 = 8\,820 + 4.95T \ln T - 0.00025T^2 - 44.95T \quad (\text{range } 823 \text{ to } 987^\circ\text{K}); \Delta F_{298.1}^0 = 3\,810 \quad (885); \text{cf. } (545, 547, 634, 1010)$$



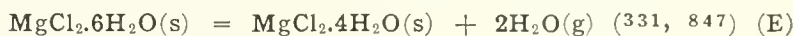
$$\Delta F^0 = 22\,480 + 4.91T \ln T - 0.00195T^2 + 0.00000037T^3 - 59.10T \quad (\text{range } 803 \text{ to } 973^\circ\text{K}); \Delta F_{298.1}^0 = 13\,040 \quad (885) \text{ from } (1010)$$



$$P_{413.1} = 0.191 \quad (847)$$

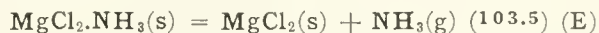


$$P_{373.1} = 0.039 \quad (847)$$

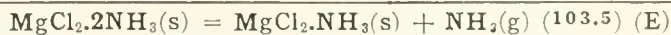


T	P	T	P
304.7	0.0021	361.95	0.0546
310.6*	0.003	370.06	0.0830
315.20	0.0036	373.1*	0.109
331.41	0.0103	377.8	0.1296
337.20	0.0149	381.3	0.1536
337.6*	0.013	383.1*	0.163
341.37	0.0174	386.2	0.1922
342.48	0.0192	388.7	0.2177
347.37	0.0280	393.1*	0.271
349.63	0.0288	403.1*	0.362
350.6*	0.030		

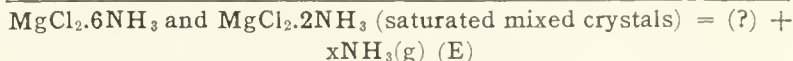
* From (847); all other values from (331).



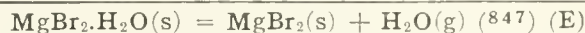
T	P	T	P
502.1	0.008	572.1	0.124
549.6	0.054	$\Delta H = 20\,800$	



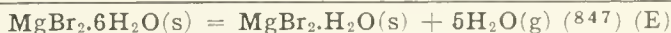
T	P	T	P
454.6	0.024	502.1	0.205
488.1	0.107	$\Delta H = 17\,900$	



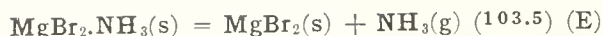
$$P_{367.1} = 0.132; \Delta H = 13\,300 \times \quad (108)$$



T	P	T	P
393.1	0.033	423.1	0.106
403.1	0.039	433.1	0.192
413.1	0.067	438.1	0.270



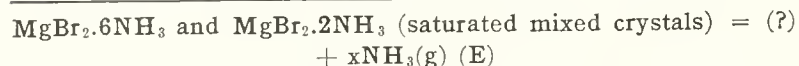
T	P	T	P
293.1	0.0139	333.1	0.163



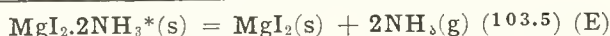
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
503.1	0.0041	573.1	0.049
550.1	0.0229	$\Delta H = 21\,700$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
488.1	0.011	550.6	0.107
503.6	0.0176	573.1	0.195
$\Delta H = 20\,100$			

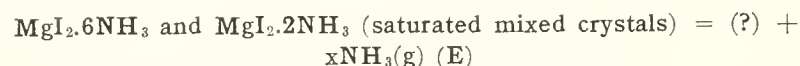


$$P_{420.1} = 0.132; \Delta H = 15\,200x \quad (103.5)$$

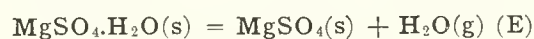
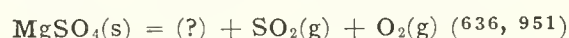


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
488.1	0.00087	503.1	0.0013
$\Delta H = 45\,400$			

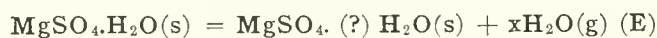
* Isambert (⁶⁶⁶) and Ephraim (³⁷⁹) give data for various magnesium halide ammoniates.



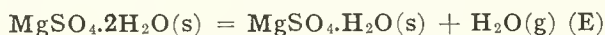
$$P_{475.1} = 0.132; \Delta H = 17\,200x \quad (103.5)$$



$$P_{298.1} = 0.0013 \quad (430)$$



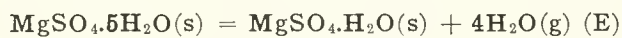
$$P_{303.85} = 0.000 \quad (148)$$



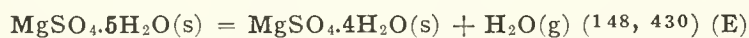
$$P_{303.85} = 0.00359 \quad (148)$$



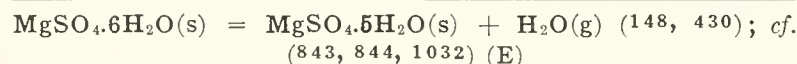
$$P_{303.85} = 0.00945 \quad (148)$$



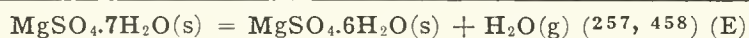
$$P_{298.1} = 0.0064 \quad (430)$$



<i>T</i> (430)	<i>P</i>	<i>T</i> (148)	<i>P</i>
298.1	0.0116	303.85	0.01646



<i>T</i> (430)	<i>P</i>	<i>T</i> (148)	<i>P</i>
298.1	0.0129	303.85	0.02094

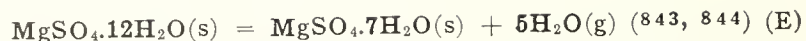


<i>T</i>	<i>P</i>	<i>T</i> *	<i>P</i>
288.05	0.00641	305.50	0.0300
293.15	0.00999	309.75	0.0413
298.10*	0.0167	313.29	0.0534
298.85	0.01601	318.17	0.0753
303.85	0.02391	318.31	0.076
304.15	0.02459		

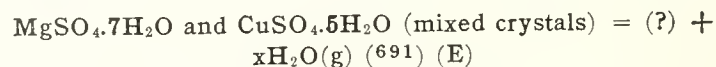
* From (²⁵⁷); all other values from (⁴⁵⁸).

Accurate single values; cf. (^{331, 843, 986, 1032, 1325})

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1 (⁶⁴¹)	0.012	303.85 (¹⁴⁸)	0.02488
298.1 (⁴³⁰)	0.0155	303.85 (²⁹⁵)	0.02496
298.1 (¹³³⁵)	0.0164	307.3 (⁸⁹⁵)	0.032

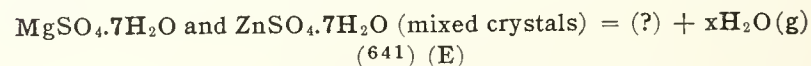


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
283.1	0.0100	293.1	0.0192



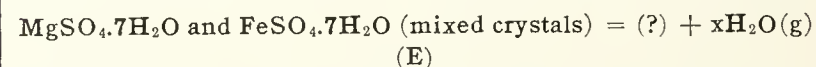
$$T = 293.1 \pm 0.02^\circ\text{K}$$

Mole % MgSO ₄	<i>P</i>	Mole % MgSO ₄	<i>P</i>
Rhombic 7H ₂ O		Monoclinic 7H ₂ O	
100.0	0.011	68.0	0.0199
97.9	0.0104	59.9	0.0197
Triclinic 5H ₂ O			
15.2	0.0062	4.5	0.0068
7.6	0.0063	0.0	0.0076

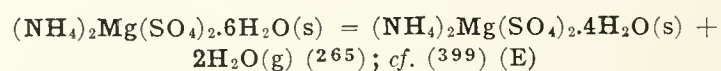


$$T = 293.1 \pm 0.02^\circ\text{K}$$

Mole % MgSO ₄	<i>P</i>	Mole % MgSO ₄	<i>P</i>
100.0	0.0105	48.8	0.0129
90.1	0.0103	44.3	0.0126
81.6	0.0101	31.7	0.0124
72.0	0.0108	23.6	0.0125
66.0	0.0114	11.2	0.0130
63.0	0.0109	0.0	0.0138
54.5	0.0114		



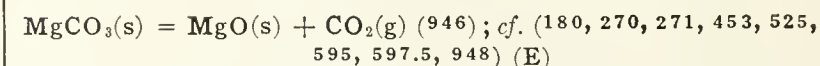
The vapor pressure of the monoclinic mixed crystals is lower, that of the rhombic higher than that of the components. At 317.11°K, the vapor pressure of the mixed crystals is equal to that of the components (¹²³⁹)



$$\log P = 2.502 + 485.1/T - 563\,500/T^2; \Delta H = 27\,400$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
315.9	0.0239	316.8	0.0259*
325.2	0.0463	309.4	0.0151*
334.3	0.0805	301.5	0.0083*
341.3	0.1221		

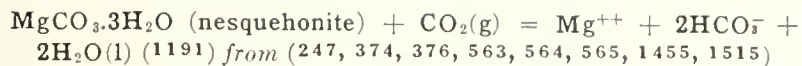
* Measured on cooling.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
673.1	0.0001	813.1	0.983
673.1	0.0037*	813.1	0.949*
723.1	0.0089	843.1	1.763
723.1	0.0076*	843.1	3.67*
763.1	0.0776	873.1	13.87*
763.1	0.0825*	973.1	473.4*
$\Delta H = 60\,863$			

* Calculated by means of equation:

$$\log k_{P_1} - \log k_{P_2} = \Delta H(T_1 - T_2)/4.571(T_1 \cdot T_2)$$



T	$c(\text{Mg}^{++})$	$c(\text{HCO}_3^-)$	$c(\text{NaCl})$	P_{CO_2}	f_{CO_2}	$\mu_c^{1/2}$	$\log (1/K_c^{1/2})$	Lit.
288.1	0.0224	0.0278		0.00039	0.000386	0.276	0.4509	(1455)
288.1	0.0233	0.0296		0.00145	0.00144	0.279	0.6164	(1455)
288.1	0.0244	0.0304		1.00210	0.00208	0.288	0.6550	(1455)
363.1	0.028	0.056		1.007	1.000	0.290	1.3522	(376*)
288.1	0.0270	0.0360		0.00330	0.00327	0.300	0.6568	(1455)
288.1	0.0324	0.0466		0.00605	0.00599	0.309	0.6433	(1455)
288.1	0.0356	0.0500		0.00618	0.00612	0.342	0.6125	(1455)
288.1	0.0505	0.0814		0.108	0.107	0.401	0.5016	(1455)
355.1	0.058	0.116		1.007	1.000	0.417	1.0359	(376*)
288.1	0.0615	0.1042		0.0136	0.0135	0.440	0.4352	(1455)
288.1	0.0830	0.1656		0.0444	0.0440	0.499	0.4288	(1455)
288.1	0.0830	0.1656		0.0547	0.0542	0.499	0.4589	(1455)
288.1	0.0830	0.1656		0.1885	0.1867	0.499	0.6380	(1455)
288.1	0.0830	0.1470		0.0154	0.0153	0.508	0.3093	(1455)
343.1	0.096	0.192		1.007	1.000	0.537	0.8170	(376*)
323.1	0.113	0.226		1.00	0.99	0.582	0.7447	(374*)
335.1	0.123	0.246		1.007	1.000	0.607	0.7094	(376*)
313.1	0.140	0.280		1.00	0.99	0.648	0.6517	(374*)
319.1	0.186	0.372		1.007	1.000	0.747	0.5298	(376*)
303.1	0.187	0.374		1.00	0.99	0.749	0.5260	(374*)
295.1	0.237	0.474		1.00	0.99	0.843	0.4231	(374)
296.1	0.209	0.418	0.121	0.96	0.95	0.864	0.4716	(247†)
285.1	0.255	0.510		0.50	0.50	0.875	0.2925	(374†)
302.4	0.260	0.520		1.004	0.996	0.883	0.3837	(376*)
291.1	0.262	0.524		1.00	0.99	0.887	0.3795	(374*)
292.6	0.306	0.612		1.005	0.995	0.958	0.3129	(376*)
285.1	0.326	0.652		1.0	0.99	0.989	0.2846	(374*)
286.5	0.337	0.674		0.993	0.984	1.005	0.2694	(376*)
285.1	0.379	0.758		1.5	1.48	1.066	0.2775	(374†)
292.6	0.393	0.786		2.1	2.08	1.086	0.3109	(376†)
291.1	0.415	0.830		2.0	1.98	1.116	0.2802	(563-565†)
285.1	0.417	0.834		2.0	1.98	1.118	0.2781	(374*)
276.6	0.422	0.844		1.0	0.99	1.125	0.1725	(374*)
292.8	0.442	0.884		3.2	3.15	1.151	0.3199	(376†)
285.1	0.443	0.886		2.5	2.48	1.153	0.2838	(374†)
291.1	0.444	0.888		2.5	2.48	1.154	0.2834	(563-565†)
285.1	0.474	0.948		3.0	2.95	1.192	0.2801	(374†)
291.1	0.508	1.016		4.0	3.93	1.234	0.2915	(563-565†)
292.1	0.516	1.032		4.7	4.58	1.244	0.3070	(376†)
285.1	0.519	1.038		4.0	3.93	1.248	0.2822	(374†)
296.1	0.206	0.412	0.965	0.96	0.95	1.258	0.4780	(247†)
292.3	0.548	1.096		5.6	5.48	1.282	0.3068	(376†)
292.3	0.575	1.150		6.2	6.05	1.313	0.3002	(376)
292.6	0.607	1.214		7.5	7.35	1.349	0.3049	(376)
285.1	0.612	1.224		6.0	5.84	1.355	0.2721	(374†)
291.8	0.671	1.342		9.0	8.80	1.418	0.2874	(376†)
291.1	0.700	1.400		10.0	9.62	1.449	0.2819	(563-565†)
291.1	0.836	1.672		16.0	14.92	1.584	0.2684	(563-565)
291.1	0.888	1.776		18.0	16.76	1.632	0.2590	(563-565)
291.1	0.888	1.776		35.0	30.17	1.632	0.3441	(563-565)
291.1	0.888	1.776		56.0	43.46	1.632	0.3969	(563-565†§)
296.1	0.210	0.420	2.21	0.96	0.95	1.685	0.4696	(247†)
296.1	0.190	0.380	3.11	0.96	0.95	1.918	0.5129	(247)
296.1	0.178	0.356	4.82	0.96	0.95	2.314	0.5414	(247)
296.1	0.105	0.210	7.50	0.96	0.95	2.795	0.7705	(247)

T	$\log p.f.$	$\Delta F^0/T$	Lit.
276.6	0.455	8.25	(374*)
285.1	0.568	7.80	(374*)
291.1	0.568	7.80	(563-565†)
291.1	0.670	9.20	(374*)
293.1	0.709	9.74	(1515)
295.1	0.709	9.74	(374*)
296.1	0.756	10.38	(247†)
303.1	0.806	11.07	(374*)
313.1	0.919	12.62	(374*)
323.1	1.006	13.82	(374*)

* 1 atm. series (374, 376). § Solid phase, $\text{Mg}(\text{HCO}_3)_2$.

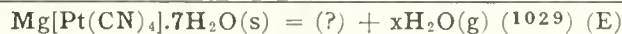
† Concentrations in molalities.

‡ Varying pressure series (374, 376).

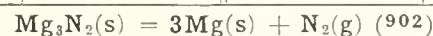


$$\Delta H = -5300; \Delta F_{298.1}^0 = 370$$

T	$m(\text{Mg}^{++})$	$\log (1/m_{\pm})$	$\mu^{1/2}$	$\log p.f.$	$\Delta F^0/T$
273.1	1.011	-0.2054	1.741	-0.024	-0.330
278.1	0.987	-0.1950	1.721	-0.009	-0.124
283.1	0.941	-0.1743	1.680	0.022	0.302
291.1	0.889	-0.1496	1.635	0.057	0.783
303.1	0.816	-0.1124	1.565	0.110	1.511
313.1	0.764	-0.0838	1.514	0.148	2.033
323.1	0.733	-0.0658	1.482	0.172	2.363
333.1	0.660	-0.020	1.407	0.230	3.159

Over $\text{H}_2\text{SO}_4(\text{aq})$

$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.01914	0.15	0.01099	0.63
0.01758	0.43	0.00974	0.67
0.01642	0.52	0.00796	0.68
0.01442	0.58		



Ca, Calcium

 $\text{Ca}(\text{l}) = \text{Ca}(\text{g})$

$\Delta F^0 = 91280 + 1.20T \ln T + 0.00076T^2 - 72.866T$ (range 1233 to 1380°K) (1191) from (1277); from Pilling (1140) and entropies $\text{Ca}(\beta) = \text{Ca}(\text{g})$, $\Delta H_0 = 41290$ and measurements on $\text{Ca}(\beta) = \text{Ca}(\text{l})$ give $\Delta H_0 = -9590$; whence $\Delta H_0 = 31700$. Undetermined errors must exist

 $\text{Ca}(\alpha)$

$\Delta H^0, \Delta F^0 = 0$; $C_p = 4.94 + 0.0042T$; $S_{298.1}^0 = 9.546$ (1191) from (86, 222, 335, 363, 365, 529, 1073)

 $\text{Ca}(\beta)$

$C_p = 6.2 + 0.00152T$; $S_{298.1}^0 = 10.827$; $\Delta F^0 = -140 - 1.26T \ln T + 0.00134T^2 + 7.511T$; $\Delta H_{298.1}^0 = 117$; $\Delta F_{298.1}^0 = 78$; $\Delta S_{298.1}^0 = 0.131$; $\Delta S_{298.1}^0$ from specific heats = 1.281 (1191)

 $\text{Ca}(\beta) = \text{Ca}(\text{l})$

$\Delta C_p = 0$; $\Delta H_{\text{M.P.}} = -9590$ (1191) from (198, 1011)

 $\text{Ca}(\beta) = \text{Ca}(\text{g})$ (1191) from (1140)

$\Delta F^0 = 40600 + 1.20T \ln T + 0.00076T^2 - 32.67T$; $\Delta H_{298.1}^0 = 40310$; $\Delta S_{298.1}^0 = 24.60$; $\Delta F_{298.1}^0 = 32980$

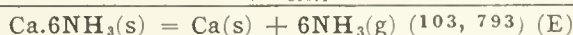
T	P	I	ΔH^0*	P (calc.)*
776.1	7.38×10^{-7}	-32.812	41463	8.36×10^{-7}
826.1	2.99×10^{-6}	-32.541	41766	3.57×10^{-6}
878.1	1.225×10^{-5}	-32.546	41834	1.67×10^{-5}
881.1	1.474×10^{-5}	-32.762	41648	1.81×10^{-5}
925.1	8.079×10^{-5}	-34.047	40512	5.29×10^{-5}
973.1	2.276×10^{-4}	-34.040	40514	1.52×10^{-4}

* From $\text{Ca}(\text{g})$; $S_{298.1}^0 = 36.71$ whence $I = -33.952$; $\Delta H_0 = 41290$; $\Delta H_{298.1}^0 = 40870$; $\Delta F_{298.1}^0 = 33285$.

 $\text{Ca}(\alpha) = \text{Ca}(\beta)$

$\Delta H_{673.1} = 100 \pm 25$; see $\text{Ca}(\beta)$

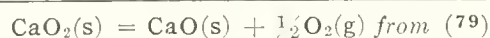
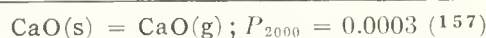
$\text{Ca}(\text{s}) = \text{Ca}^{++}$; $E_{300.1}^0 = 2.77$ (1418)



T	P	T	P
262.1	0.0230	294.8*	0.114
273.1*	0.0300	304.3	0.204
283.9*	0.0605	316.8*	0.4035
290.4	0.0908	$\Delta H = 61920$	

* From (793); all other values from (103).

$\text{CaO}(\text{s})$; $C_p = 11.0 + 0.0008T$ (1191)

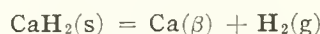
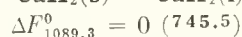
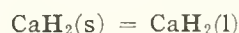
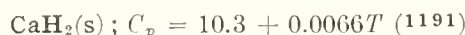


<i>T</i>	<i>P</i>	<i>I</i> *	<i>I</i> †	<i>I</i> ‡
473.1	0.1228	-16.35	-10.50	-31.85
523.1	.1330	-15.51	-10.52	-29.83
573.1	.1411	-15.35	-10.50	-28.14
623.1	.1632	-15.16	-10.71	-26.92
673.1	.1998	-15.15	-11.03	-26.04

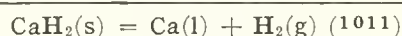
* Upper temp. range gives $\Delta F^0 = 3\,470 - 15.2T$; $\Delta F_{298.1}^0 = -1\,060$.

† Lower temp. range gives $\Delta F^0 = 700 - 10.5T$; $\Delta F_{298.1}^0 = -2\,430$.

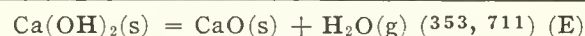
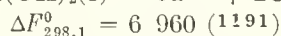
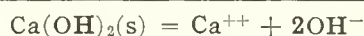
‡ de Forcrand (435) found $\Delta H = 10\,800$; or $\Delta F^0 = 10\,800 - 28.56T$; $\Delta F_{298.1}^0 = 2\,290$.



$\Delta F^0 = 47\,370 - 2.4T \ln T + 0.00209T^2 - 22.778T$ (range 914 to 1020°K); $\Delta H_{298.1}^0 = 47\,900$; $\Delta F_{298.1}^0 = 36\,690$ (1191) from (198); $\Delta H_{291.1}^0 = 45\,100$ (528); cf. (394, 794)



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 053.1	0.0145	1 236.1	0.465
1 098.1	.0592	1 259.1	.580
1 146.1	.125	1 279.1	.716
1 190.1	.243	1 300.1	.928



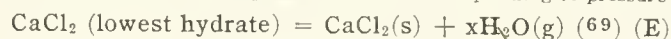
$\Delta H_{291.1}$ (Thomsen) 25 190; ΔH calculated by equation $d \ln P/dt = \Delta H/RT^2 = 25\,400$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
574.1*	0.00350	701.1	0.072†
593.8*	0.00708	707.1	0.084
603.1*	0.00976	717.1*	0.2308
606.9*	0.01103	721.1	0.121†
609.6*	0.01218	721.1	0.125†
613.7*	0.01388	731.1	0.158
614.8*	0.01440	740.1	0.191†
620.7*	0.01762	741.1	0.196†
622.8*	0.01863	759.1	0.305
639.1	0.013†	761.1	0.308†
642.1	0.0121†	773.1	0.417†
650.1	0.021†	776.1	0.439†
662.1	0.0229†	780.1	0.467†
663.1	0.032†	780.1	0.476
663.8*	0.0617†	797.1	0.668†
670.1	0.032†	797.1	0.695
674.2*	0.0805†	800.1	0.692†
681.1	0.0414†	804.1	0.879
690.1	0.046†	812.1	0.863†
694.4*	0.1332†	830.1	1.000†

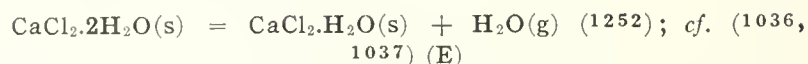
* From (353); all other values from (711). The values of Dragert and Johnston differ materially. It is difficult to say which are the better values.

† Average of two determinations at neighboring temperatures.

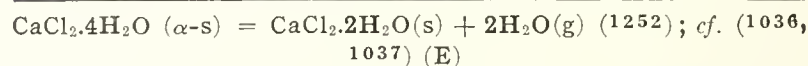
‡ Interpolated according to equation: $t = 1.98t_w + 349$, where t = temperature of substance and t_w = temperature of H_2O corresponding to pressure P .



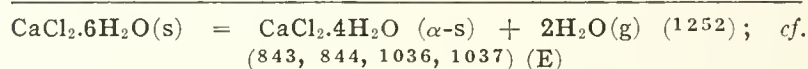
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.00009	323.1	0.00176
298.1	0.00045		



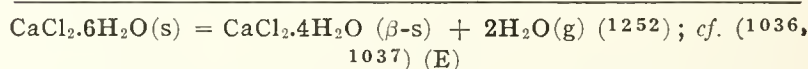
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
338.1	0.017	428.1	0.576
351.1	0.032	438.1	0.799
373.1	0.079	443.1	0.941
402.1	0.230	448.6	1.108



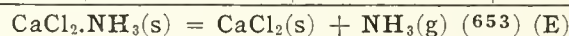
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
258.1	0.00022	303.1	0.00610
273.1	0.00078	308.1	0.00824
283.1	0.00164	313.1	0.01122
293.1	0.00326	318.4	0.01549
298.1	0.00447		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
258.1	0.00036	293.1	0.00497
273.1	0.00121	298.1	0.00668
283.1	0.00253	302.9	0.00895



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
258.1	0.00029	293.1	0.00414
273.1	0.00100	298.1	0.00568
283.1	0.00213	302.3	0.00746

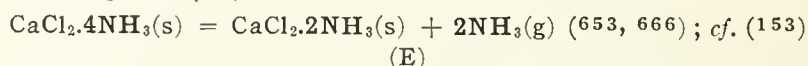


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
381.8	0.0041	487.8	1.089
426.6	0.088		$\Delta H = 16\,500$



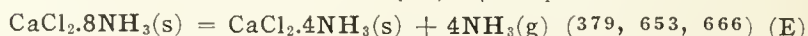
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
381.7	0.0503	426.6	0.588
399.1	0.132	453.1*	1.000*
409.7	0.230		$\Delta H = 15\,100$

* Extrapolated (666).



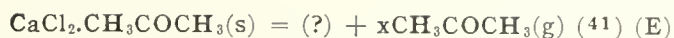
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.086	306.1	0.654
283.1*	0.168	310.1*	0.778
287.1	0.207	315.1	1.000†
291.1	0.262	319.1*	1.241
299.5*	0.418	326.1*	1.603
			$\Delta H = 20\,200$

* From (666); all other values from (653). † Interpolated.

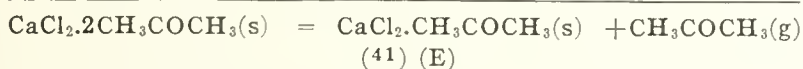


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
267.6	0.094	297.1	0.632
273.1	0.147	298.7*	0.697
273.1*	0.186	301.1†	0.921
279.1	0.205	301.1	0.816
283.1	0.264	305.1	0.917
284.3*	0.317	306.1	1.000†
287.1†	0.388	303.7*	1.053
287.5*	0.375	312.1*	1.422
293.1	0.500	316.6*	1.778
293.5*	0.513		$\Delta H = 39\,200†$

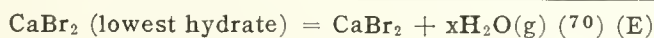
* From (666). † From (653); all other values from (379). ‡ Interpolated.



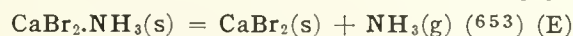
T	P	T	P
310.1	0.007	337.1	0.066
323.1	0.020		



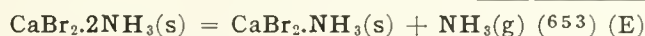
T	P	T	P
293.1	0.054	322.1	0.629
299.1	0.114	327.1	0.820
304.1	0.183	330.1	0.980
309.1	0.263	333.1	1.105
315.1	0.395	335.1	1.214



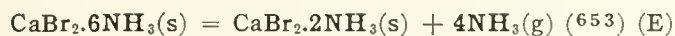
T	P	T	P
273.1	0.00012	323.1	0.00025
298.1	0.00024		



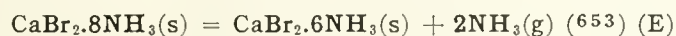
T	P	T	P
488.1	0.151	503.1	0.255
$\Delta H = 18\ 600$			



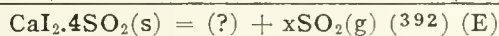
T	P	T	P
410.1	0.013	488.1	0.592
426.1	0.0454		$\Delta H = 17\ 100$



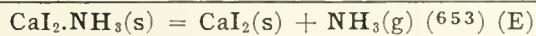
T	P	T	P
273.1	0.0067	350.1	0.549
336.5	0.295	351.3	0.588
$\Delta H = 46\ 800$			



T	P	T	P
273.1	0.153	296.1	0.636
$\Delta H = 19\ 600$			



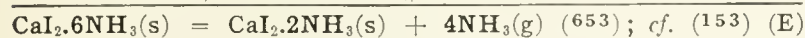
T	P	T	P
273.1	0.074	300.6	0.638
289.1	0.099	306.1	1.000
290.6	0.316		$\Delta H = \text{ca. } 10\ 700x$



T	P	T	P
488.1	0.061	503.1	0.100
$\Delta H = 19\ 500$			



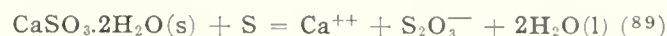
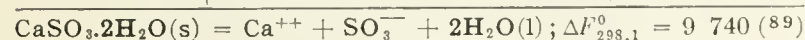
T	P	T	P
427.1	0.0036	503.1	0.170
488.1	0.103		$\Delta H = 19\ 000$



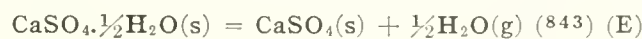
T	P	T	P
380.1	0.115	409.8	0.401
409.4	0.383		$\Delta H = 56\ 000$



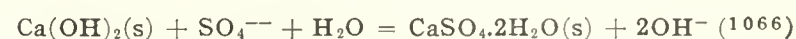
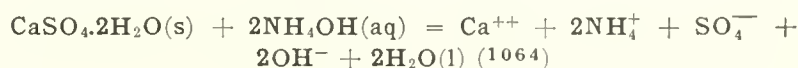
T	P	T	P
194.8	0.0017	252.1	0.461
233.1	0.038	261.1	0.891
$\Delta H = 17\ 200$			



T		m
352.9	S (rhomb)	1.120
373.1	S (monocl)	0.713
383.1	S (monocl)	0.618
395.1	S $_{\lambda, \mu}$ (l)	0.417
414.1	S $_{\lambda, \mu}$ (l)	0.2665



T	P	T	P
373.1	0.0230	421.1	0.220
387.1	0.037	434.6	0.395
397.1	0.0586		

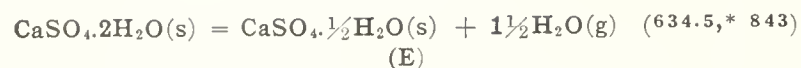


$c(\text{OH}^-)$	$c(\text{SO}_4^{--})$	$c(\text{Ca}^{++})$	K_c
$T = 288.1^\circ\text{K}$			
0.1786	0.702	0.00250	0.0454
.1818	.925	.00250	.0357
.1625	.437	.00271	.0604
.1632	.431	.00268	.0617
.1370	.199	.00325	.0942
.1357	.193	.00332	.0952
.0972	.0674	.00571	.140
.0968	.0682	.00526	.138
.0737	.0326	.00696	.167
.0745	.0336	.00687	.165

$T = 313.1^\circ\text{K}$			
0.1314	0.460	0.00152	0.0376
.1305	.455	.00153	.0375
.1086	.216	.00232	.0545
.1119	.218	.00225	.0573
.0770	.072	.00401	.0827
.0776	.077	.00392	.0783
.0596	.0374	.00517	.0950
.0576	.044	.00544	.0760

$T = 343.1^\circ\text{K}$			
0.1212	0.713	0.00071	0.0207
.1024	.477	.00098	.0221
.1118	.4810	.00089	.0259
.0675	.2287	.00130	.0334
.0864	.2241	.00134	.0332
.0596	.0822	.00241	.0433
.0588	.0832	.00244	.0416
.0440	.0383	.00357	.0506
.0436	.0355	.00360	.0535

$T = 373.1^\circ\text{K}$			
0.1054	0.727	0.00018	0.0153
.1092	.930		.0128
.0904	.487	.00041	.0167
.0880	.478	.00045	.0162
.0708	.243	.00082	.0206
.0693	.234	.00089	.0205
.0485	.0912	.00187	.0258
.0499	.0908	.00178	.0274
.0334	.0482	.00303	.0230
.0360	.0472	.00271	.0274



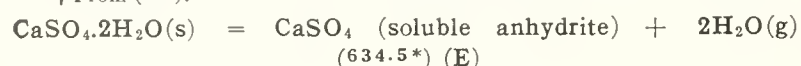
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
290.1	0.00661	345.1	0.2366
298.1	0.0120	350.2	0.3136
321.1	0.0617	355.85	0.4209
323.1	0.0651	373.1†	0.881–0.942
333.1	0.1180	374.55	0.9984

$$\Delta H = 3 \ 921$$

* Values of *P* also calculated according to equation:

$\log P = \log P_w + 1.493 - 567.7/T$ where P_w = the vapor pressure of the water.

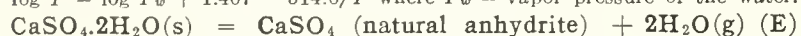
† From (843).



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.4	0.0096	333.1	0.1417
298.1	0.0188	345.1	0.2712
321.9	0.0759	$\Delta H = 4 \ 740$, Thomsen	

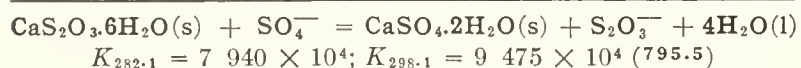
* Also gives calculated values, according to equation:

$\log P = \log P_w + 1.407 - 514.6/T$ where P_w = vapor pressure of the water.

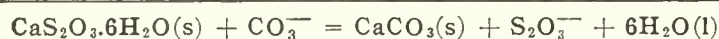


$\Delta H = 4 \ 606$ (634.5); calculated values of *P* according to equation:

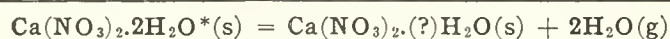
$$\log P = \log P_w + 1.486 - 500/T$$



$$K_{282.1} = 7 \ 940 \times 10^4; K_{298.1} = 9 \ 475 \times 10^4 \quad (795.5)$$

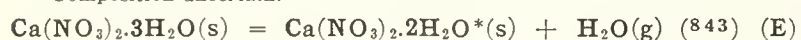


$$K_{298.1} = 10^2 \quad (795.5)$$



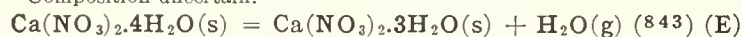
$$P_{303.1} = 0.0036 \quad (843)$$

* Composition uncertain.

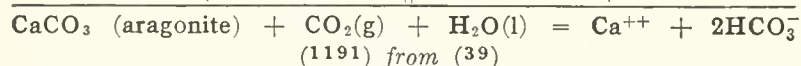


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.0013	313.1	0.0080
303.1	0.0047		

* Composition uncertain.



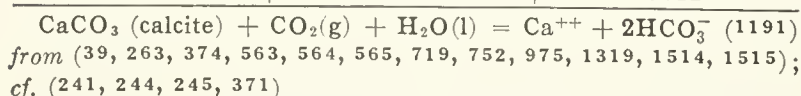
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
283.1	0.0014	308.1	0.0096
293.1	0.0025	313.1	0.0126
303.1	0.0058		



$$\Delta S_{298.1}^0 = -54.807; \Delta H_{298.1}^0 = -8 \ 550; \Delta F_{298.1}^0 = 7 \ 788$$

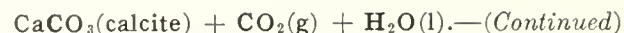
<i>T</i>	<i>c</i> (Ca ⁺⁺)	<i>c</i> (HCO ₃ ⁻)	<i>f</i> CO ₂	$\mu_c^{1/2}$	$\log (1/K_c^{1/2})$
308.1	0.00876	0.01752	0.969	0.162	1.8522
298.1	.01066	.02132	.992	.179	1.7703
282.1	.0146	.0292	1.012	.209	1.6366

<i>T</i>	$\log p.f.$	$\Delta F^0/T$
282.1	1.783	24.49
298.1	1.901	26.11
308.1	1.974	27.12



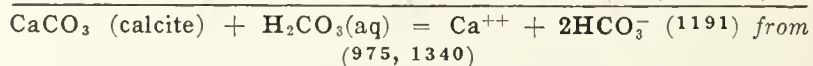
$$\Delta S_{298.1}^0 = -55.579; \Delta H_{298.1}^0 = -8 \ 588; \Delta F_{298.1}^0 = 7 \ 980$$

<i>T</i>	<i>c</i> (Ca ⁺⁺)	<i>c</i> (HCO ₃ ⁻)	<i>p</i> CO ₂	<i>f</i> CO ₂	$\mu_c^{1/2}$	$\log (1/K_c^{1/2})$	Lit.
323.1	0.000293	0.000586		0.000300	0.030	2.1581	(752)
298.1	.000461	.000922		.000300	.037	1.9595	(752)
303.1	.00055	.00110		.000315	.041	1.8916	(1514, 1515)
296.1	.00057	.00114		.000315	.041	1.8761	(1514, 1515)
295.1	.00057	.00114		.000315	.041	1.8761	(1514, 1515)



<i>T</i>	<i>c</i> (Ca ⁺⁺)	<i>c</i> (HCO ₃ ⁻)	<i>p</i> CO ₂	<i>f</i> CO ₂	$\mu_c^{1/2}$	$\log (1/K_c^{1/2})$	Lit.
294.1	0.00059	0.00118		0.000315	0.042	1.8612	(1514, 1515)
294.1	.00061	.00122		.000315	.043	1.8466	(1514, 1516)
289.1	.000747	.001462		.000500	.047	1.8323	(1319)
274.1	.00082	.00164		.000315	.050	1.7182	(1514, 1515)
289.1	.000850	.001674		.000800	.051	1.8419	(1319)
289.1	.001372	.002728		.00330	.064	1.8364	(1319)
289.1	.002231	.004452		.01374	.082	1.8296	(1319)
289.1	.002965	.005922		.02792	.094	1.8096	(1319)
289.1	.003600	.007194		.04958	.104	1.8082	(1319)
289.1	.005330	.010656		.1408	.127	1.7882	(1319)
289.1	.006634	.013264		.2513	.141	1.7776	(1319)
308.1	.007650	.015300		.969	.151	1.9110	(39)
289.1	.007875	.015748		.4125	.154	1.7751	(1319)
289.1	.008855	.017708		.5478	.163	1.7650	(1319)
298.1	.009430	.018860		.992	.168	1.8236	(39)
289.1	.009720	.019440		.7224	.175	1.7646	(1319)
289.1	.010860	.021720		.9743	.180	1.7609	(1319)
289.1	.010850	.021700	1.0	.99	.180	1.7622	(374)
288.1	.01175	.02350		.92	.188	1.7235	(263)
282.1	.0130	.0260		1.012	.198	1.6871	(39)
289.1	.014110	.028220	2.0	1.98	.206	1.7485	(374)
273.1	.0156	.0312		0.92	.216	1.5967	(263)
289.1	.018340	.036680	4.0	3.93	.235	1.7340	(374)
289.1	.021390	.042780	6.0	5.84	.253	1.7247	(374)
328.1	.0255	.0510	56.0	46.93	.277	1.9499	(563–565)
291.1	.0256	.0512	10.0	9.62	.277	1.7188	(563–565)
291.1	.0283	.0566	14.0	13.24	.291	1.7214	(563–565)
291.1	.0307	.0614	18.0	16.76	.303	1.7203	(563–565)
218.1	.0339	.0678	56.0	45.92	.319	1.8231	(563–565)
391.1	.0342	.0684	25.0	22.58	.320	1.7164	(563–565)
291.1	.0380	.0760	35.0	30.17	.338	1.7127	(563–565)
308.1	.0380	.0760	56.0	44.97	.338	1.7704	(563–565)
291.1	.0393	.0786	56.0	43.46	.343	1.7509	(563–565)
298.1	.0403	.0806	56.0	44.07	.348	1.7420	(563–565)

<i>T</i>	$\log p.f.$	$\Delta F^0/T$	Lit.
273.1	1.747	24.00	(263)
274.1	1.763	24.20	(1514, 1515)
282.1	1.828	25.11	(39)
288.1	1.860	25.55	(263)
289.1	1.892	25.99	(374)
289.1	1.892	25.99	(1319)
291.1	1.951	26.79	(563–565)
294.1	1.886	25.89	(1514, 1515)
294.1	1.898	26.08	(1514, 1515)
295.1	1.914	26.28	(1514, 1515)
296.1	1.914	26.28	(1514, 1515)
298.1	1.949	26.77	(39)
298.1	1.944	26.70	(563–565)
298.1	1.994	27.39	(752)
298.1	1.949	26.77	(975)
303.1	1.929	26.50	(1514, 1515)
308.1	2.026	27.83	(39)
308.1	1.969	27.03	(563–565)
318.1	2.015	27.68	(563–565)
323.1	2.184	30.00	(752)
328.1	2.079	28.56	(563–565)



$$\log p.f._{298.1} = 1.458; \Delta F_{298.1}^0 = 5 \ 970$$

<i>c</i> (H ₂ CO ₃)	<i>c</i> (Ca ⁺⁺)	<i>c</i> (HCO ₃ ⁻)	$\mu_c^{1/2}$	$\log (1/K_c^{1/2})$	Lit.
0.00269	0.00370	0.00740	0.105	1.3744	(1340)
.00104	.00363	.00244	.110	1.3595*	(1340)
.00363	.00414	.00828	.111	1.3685	(1340)
.00352	.00412	.00824	.111	1.3666	(975)
.00181	.00423	.00304	.117	1.3545*	(1340)
.00206	.00436	.00317	.119	1.3572*	(1340)
.00475	.00278	.01181	.121	1.3627†	(1340)
.00315	.00473	.00364	.124	1.3676*	(1340)

CaCO₃(calcite) + H₂CO₃(aq).—(Continued)

$c(\text{H}_2\text{CO}_3)$	$c(\text{Ca}^{++})$	$c(\text{HCO}_3^-)$	$\mu_c^{1/2}$	$\log (1/K_c^{1/2})$	Lit.
0.00406	0.00170	0.01590	0.133	1.3251†	(1340)
.00455	.00560	.00441	.134	1.3393*	(1340)
.0100	.00604	.01208	.135	1.3516	(1340)
.00395	.00931	.00612	.136	1.3514§	(1340)
.00656	.00611	.00492	.139	1.3814*	(1340)
.0114	.00657	.01314	.140	1.3340	(1340)
.00356	.00662	.00350	.152	1.3468	(1340)
.0373	.00973	.01946	.171	1.3351	(975)
.00494	.01004	.00379	.191	1.3109¶	(1340)
.00256	.00406	.00812	.193	1.3269**	(1340)
.00310	.00412	.00824	.193	1.3482††	(1340)
.00444	.00461	.00922	.197	1.3513‡‡	(1340)
.001875	.00366	.00732	.227	1.3272§§	(1340)
.333	.0224	.0448	.259	1.2897	(975)
.444	.0250	.050	.274	1.2838	(975)
.550	.0260	.052	.279	1.2976	(975)
.858	.0260	.052	.279	1.3620	(975)

* 0.00199M_e CaSO₄ added. † 0.00625M_e NaHCO₃ added. ‡ 0.0125M_e NaHCO₃ added. § 0.00625M_e CaCl₂ added. || 0.00312M_e CaSO₄ added. ¶ 0.00625M_e CaSO₄ added. ** 0.00625M_e NaCl added. †† 0.0125M_e NaCl added. ‡‡ 0.0625M_e MgSO₄ added. §§ 0.0125M_e Na₂SO₄ added. ||| Solid phase Ca(HCO₃)₂. (M_e = Moles per liter.)



$$\Delta F^0 = 42\,216 - 2.4T \ln T + 0.00355T^2 + 0.00000031T^3 - 23.698T \quad (1191) \text{ from } (1390.5); \text{ or } -23.753T \quad (1191) \text{ from } (718); \Delta F_{298.1}^0 = 31\,384 \quad (1191)$$

T	P	T	P
1 115.4	0.4513	1 210.1	1.770
1 126.0	0.5245	1 322.4	6.439
1 127.6	0.5317	1 355.6	8.892
1 142.0	0.6722	1 430.8	18.687
1 177.4	1.157	1 499.4	34.333
1 179.6	1.151	1 514.0	39.094

$\Delta H = 43\,300$, Berthelot

The various forms of CaCO₃, chalk, marble, calcite and aragonite give identical values within the accuracy of the measurements. For pressure values above the eutectic temperature, see the original article.

CaCO₃ with only 0.38% CaO melts at 1662.1°K and has at that temperature a pressure of 1.025 atm.

The formula: $\log P = -11\,355/T - 5.388 \log T + 26.238$, calculated from the experimentally determined values, gives:

T	P^*	T	P^*
773.1	0.000096	1 173.1	1.043
823.1	0.00054	1 223.1	2.075
873.1	0.00242	1 273.1	3.871
923.1	0.00908	1 323.1	6.837
973.1	0.0292	1 373.1	11.499
1 023.1	0.0832	1 423.1	18.092
1 073.1	0.220	1 473.1	28.680
1 123.1	0.489	1 513.1	39.66
1 170.1	1.000		

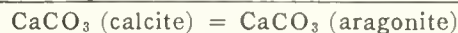
* In good agreement with these values (1394) finds $P = 0.000004-0.000012$ at 673.1°K; cf. (1154, 1227, 1560).

Johnston (718) worked with very small quantities of materials and found $P = 1$ atm. at 1171.1°K. According to Johnston, P can be calculated according to the formula:

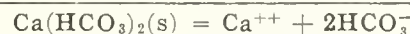
$\log P = -9\,340/T + 1.1 \log T - 0.0012T + 6.001$. By the hastening of equilibrium through the addition of basic compounds such as Li₂CO₃ or Na₂CO₃, Zavrieff (1560) obtained somewhat higher pressures at lower temperatures, but on the other hand lower pressures at the higher temperatures. ($P = 1$

atm. at 1182.1°K.) The values of Riesenfeld (1227) occupy a mean position. He gives the equation: $\log P = -9\,300/T + 1.75 \log T + 0.011916T - 20\,323 \times 10^{-9}T^2 + 82\,446 \times 10^{-13}T^3 + 0.319$; cf. (180, 453, 525, 839).

According to Lebeau (836), mixtures with alkali carbonates have a lower CO₂ pressure than the pure CaCO₃; they also include double carbonates; cf. (837).



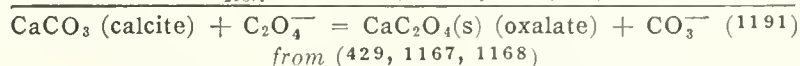
$$\Delta S_{298.1}^0 = 0.772; \Delta H_{298.1} = 38; \Delta F_{298.1}^0 = -192 \quad (1191) \text{ from } (39)$$



$$\Delta F_{298.1}^0 = 6\,399 \quad (1191)$$

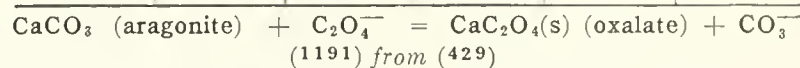


$$\Delta F_{298.1}^0 = -429 \quad (1191) \text{ from } (975)$$



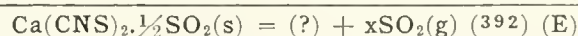
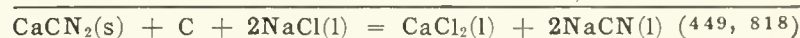
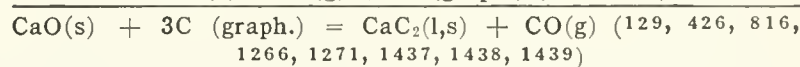
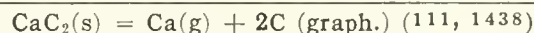
$$\Delta H_{298.1} = -7\,460; \Delta F_{298.1}^0 = -306 \quad (1191)$$

T	$c(\text{K}_2\text{C}_2\text{O}_4)$	$c(\text{K}_2\text{CO}_3)$	$c(\text{KCl})$	μ_c	K_c
298.1	0.080	0.303	0.034	1.183	3.8
298.1	.084	.299	.034	1.183	3.6
298.1	.1869	.3131		1.50	1.675
298.1	.159	.607	.068	2.37	3.8
298.1	.160	.606	.068	2.37	3.8
298.1	.166	.600	.068	2.37	3.6
322.8	.3062	.1938		1.50	0.633
332.1	.3531	.1469		1.50	.416
369.1	.266	.117		1.183	.44



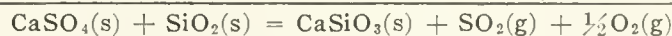
$$\Delta H_{298.1} = -7\,225; \Delta F_{298.1}^0 = -484$$

T	$c(\text{K}_2\text{C}_2\text{O}_4)$	$c(\text{K}_2\text{CO}_3)$	μ_c	K_c
298.1	0.1532	0.3467	1.50	2.262
322.8	.2682	.2318	1.50	0.864
332.1	.3302	.1698	1.50	.514



T	P	T	P
268.1	0.046	292.6	0.362
273.1	0.086	300.6	0.562
284.6	0.224	307.1	1.000 (extrap.)

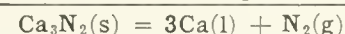
$\Delta H = 10\,740x$



$$P_{1546} = 1.00 \text{ (extrap.) } (950)$$

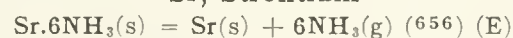


$$P_{1636} = 1.00 \text{ (extrap.) } (950)$$



$$\log p = -24\,360/T + 13.285 \quad (794)$$

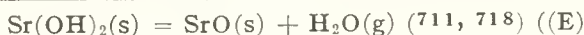
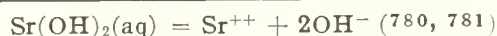
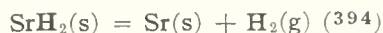
Sr, Strontium



T	P	T	P
273.1	0.0555	293.1	0.175
278.6	0.071	297.1	0.207
284.1	0.103	300.1	0.255
287.6	0.120	306.6	0.362*
291.1	0.154	319.1	1.000*

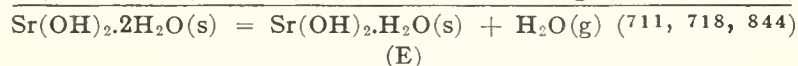
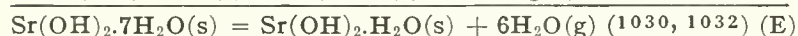
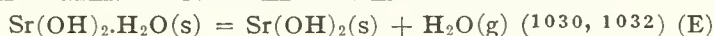
$\Delta H = 59\,460$

* Extrapolated from Roederer (1238).



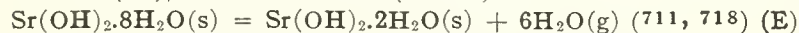
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
703.1	0.0089	907.1	0.196
725.1	0.0121	912.1	0.217
733.1	0.0141	943.1	0.308
743.1	0.0158	952.1	0.367
761.1	0.0229	962.1	0.413
776.1	0.0276	979.1	0.467
797.1	0.0414	994.1	0.567
819.1	0.054	1 013.1	0.689
834.1	0.072	1 015.1	0.692
870.1	0.109	1 027.1	0.811
870.1	0.121	1 038.1	0.862
901.1	0.197	1 051.1	1.000

$\Delta H = 27\,350$ (Thomsen); $\Delta H = 20\,700$; $t = 3.62t_w + 416$, where t_w = the temperature at which the pressure of pure water is equal to that of the substance at the temperature t .



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
326.7	0.038	358.1*	0.126
332.2	0.050	361.0	0.141
343.3	0.075	362.6	0.150
352.3	0.107	373.1*	0.314

* From (844); all other values from (711, 718).

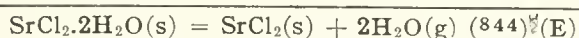


$\Delta H = 106\,800$; $\Delta H = 109\,980$ (Thomsen)

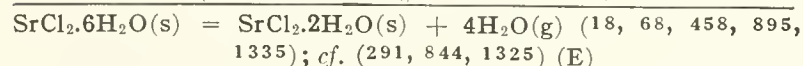
For the compound of composition $\text{Sr}(\text{OH})_2 \cdot 4.2\text{H}_2\text{O}$:

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.3	0.0146	335.6	0.2003
301.0	0.0313	343.6	0.2888
311.5	0.0589	353.1	0.428
323.4	0.1091	363.2	0.624

$t = t_w + 2.2$, where t_w = the temperature at which the pressure of pure water is equal to that of the substance at temperature t . A material of the composition $\text{Sr}(\text{OH})_2 \cdot 2.2\text{H}_2\text{O}$ (composed of the 9- and 2-hydrate), shows an average pressure between the two, according to the equation $t = 0.93t_w + 17$ (711, 718). The values of (844) are too low

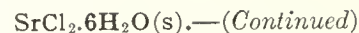


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.0024	353.1	0.091
313.1	0.0074	373.1	0.309



Menzies (986) considers the values of (18) to be more accurate than those of Frowein (458); $\Delta H = 12\,760$, calculated according to van't Hoff equation (458)

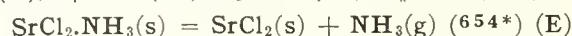
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
248.1 (63)	0.00007*	298.1 (63)	0.01101
258.1 (63)	0.00014*	298.1	0.01121
273.1 (63)	0.00050	298.76‡	0.01029
287.85‡	0.00432	298.7†	0.01147
288.1 (63)	0.00525	303.0†	0.01557
292.8†	0.00738	303.11‡	0.01430
293.44‡	0.00676	307.2†	0.02083



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
307.3§	0.0186	312.55‡	0.02838
307.76‡	0.02016	313.1 (63)	0.03157*
310.65†	0.02617	323.1 (63)	0.06126*

* Interpolated according to equation: $\log P = 7.785 - 2794.1/(T + 152)$.

† From (18). ‡ From (458). § From (895). || From (1335).

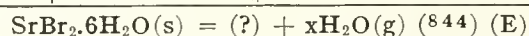


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.083	351.1	0.395
336.1	0.317	381.1	0.541
$\Delta H = 11\,500$			

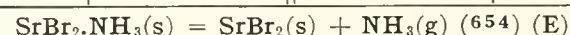
* These values are not very reliable.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.105	305.9	0.803
291.1	0.339	$\Delta H = 9\,900x$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.0023	313.1	0.0071



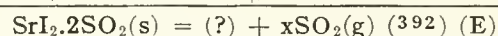
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
427.1	0.151	488.1	0.541
$\Delta H = 16\,800$			



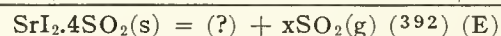
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
336.1	0.102	350.1	0.363
$\Delta H = 12\,800$			



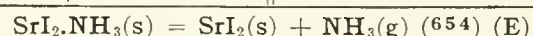
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.012	326.1	0.842
332.1	0.672	$\Delta H = 65\,400$	



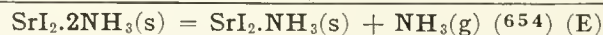
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.039	315.6	1.000 (extrap.)
$\Delta H = 11\,060x$			



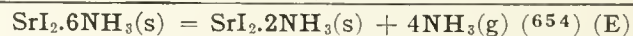
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.118	292.1	0.329
279.1	0.171	307.1	1.000 (extrap.)
286.1	0.245	$\Delta H = 10\,740x$	



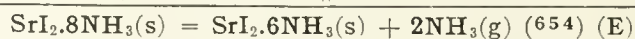
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
481.1	0.155	503.1	0.330
488.1	0.200	$\Delta H = 18\,300$	



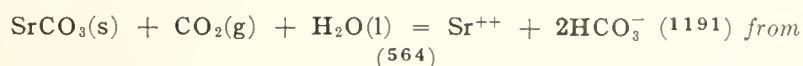
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
380.1	0.039	426.1	0.258
410.1	0.151	$\Delta H = 15\,500$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
336.1	0.087	380.6	0.574
349.7	0.143	$\Delta H = 50\,400$	



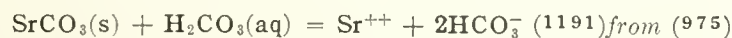
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.012	324.1	0.439
306.1	0.139	332.6	0.658
309.1	0.174	$\Delta H = 22\,000$	



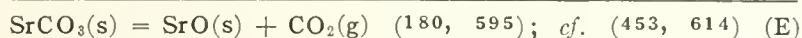
$$\Delta H_{298.1} = -6\,740; \Delta F_{298.1}^0 = 9\,052 \text{ (1191)}$$

T	$m_{(\text{Sr}^{++})}$	p_{CO_2}	f_{CO_2}	$\mu^{1/2}$	$\log (1/m_{\text{Sr}^{++}}^{1/2})$
291.1	0.00812	1	0.99	0.156	1.8882
291.1	.0257	35*	30.17	.278	1.8826

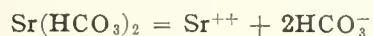
* And greater pressures.



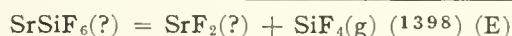
$$K_{298.1} = 6.93 \times 10^{-6}; \Delta H_{298.1} = -1\,940; \Delta F_{298.1}^0 = 7\,042$$



T (180)	P	T (595)	P
1 428.1	1.00	1 418.1	1.00



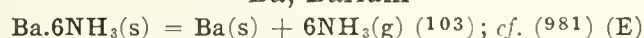
$$K_{291.1} = 1.83 \times 10^{-5}; \Delta F_{291.1}^0 = 6\,314 \text{ (1191) from (564)}$$



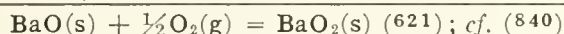
T	P	T	P
752.7	0.0293	810.1	0.3518
780.6	0.0857	827.3	0.6895
795.7	0.2004	834.7	0.8953
808.6	0.3319	844.2	1.2555

$$\text{SrF}_2/\text{SrSiF}_6 = 0.274 \text{ in solid phase; } \log P = -20\,680/4.571T + 1.751 \log T + 0.319.$$

Ba, Barium

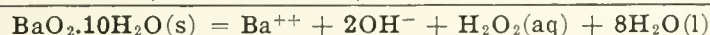


T	P	T	P
248.1	0.017	273.1	0.081
261.1	0.037		$\Delta H = 57\,900$

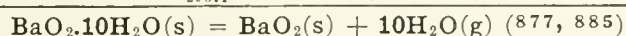


$$\Delta F_{298.1}^0 = -13\,200 \text{ (885)}$$

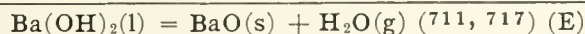
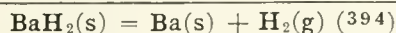
T	P	T	P
891.1	0.0149	1 067.1	0.497
928.1	.0353	1 108.1	.945
970.1	.0861	1 126.1	1.220
1 010.1	.1855	1 141.1	1.534



$$K_{273.1} = 18.5 \times 10^{-12}; \Delta H = 23\,700; K_{298.1} = 7.17 \times 10^{-10}; \Delta F_{298.1}^0 = 12\,840 \text{ (877, 885)}$$



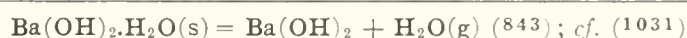
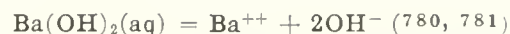
T	P	T	P
295.1	0.0197	304.1	0.0372
298.1	.0245		$\Delta F_{298.1}^0 = 22\,000$



$$\Delta H \text{ (Thomsen)} = 31\,800; \Delta H = 27\,780 \text{ gives } P\text{'s as below; } \Delta F_{298.1}^0 = 25\,900 \text{ (885)}$$

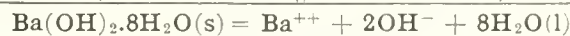
T	P	I	T	P	I
903.1	0.0121*		1 130.1	0.278	
918.1	0.0158		1 143.1	0.308*	
943.1	0.0229*	21.945	1 164.1	0.429	
953.1	0.025		1 183.1	0.467*	21.967
983.1	0.0414*		1 187.1	0.507	
1 022.1	0.072	21.958	1 223.1	0.661	
1 022.1	0.074		1 224.1	0.692*	
1 059.1	0.125		1 239.1	0.764	
1 062.1	0.121*		1 263.1	0.921	
1 102.1	0.196*	21.967	1 261.1	1.000*	

* Values calculated from $t = 4.0t_w + 590$, where t = temperature of substance; t_w = temperature of H_2O corresponding to P .

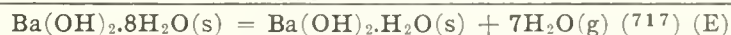


$$\Delta H = 14\,800; \Delta F_{298.1}^0 = 4\,650 \text{ (885)}$$

T	P	T	P
350.1	0.018	373.1	0.059

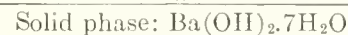


$$\Delta F_{298.1}^0 = 3\,140 \text{ (885)}$$

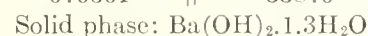


$$\Delta F_{298.1}^0 = 18\,350 \text{ (885); } \Delta H \text{ (Thomsen)} = 94\,500; = 93\,380 \text{ (717)}$$

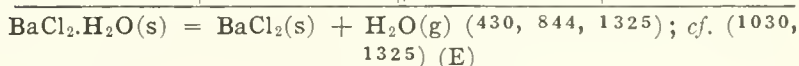
T	P	T	P
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290.8	0.0047	327.4	0.0604
305.3	0.0130	328.4	0.0675
312.2	0.0222	331.0	0.0791
313.9	0.0233	337.0	0.1204
323.9	0.0501	338.0	0.1241



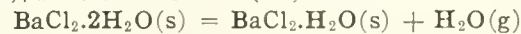
285.0	0.0022	341.9	0.150
307.1	0.0161	349.0	0.226
331.1	0.0776	356.9	0.346
332.6	0.0850	360.1	0.414



$$P_{314.1} = 0.0034$$

T	P	T	P
298.1*	0.0033	353.1	0.0665
313.1	0.005	373.1	0.357
333.1	0.0269		

* From (430); all other values from (844).

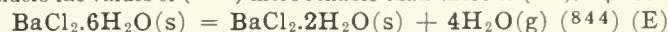


$$(66, 458, 1325); \text{ cf. (291, 844, 986, 1035, 1036) (E)}$$

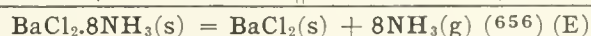
$$P_{298.1} = 0.0063 \text{ (430); } = 0.00692 \text{ (1113); } = 0.00724 \text{ (1335); } = 0.0076 \pm 0.0001 \text{ (1531); } \Delta H = 3\,820 \text{ (458); cf. (1325)}$$

T	P	T	P
273.1	0.00124*	303.1	0.01063*
283.1	0.00259*	304.75†	0.01077
288.1	0.00372	308.05‡	0.01529
288.1‡	0.00314	308.1	0.01489*
289.1‡	0.00347	309.3†	0.01709
291.35	0.00391	309.55†	0.01677
293.1	0.00532*	309.95†	0.01725
298.1	0.00754	310.4†	0.01774
298.78†	0.00718	313.1	0.02077
299.0†	0.00730	316.55†	0.02779
301.95†	0.00938	323.1	0.03967*
303.05†	0.01047		

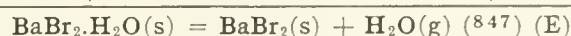
* Values calculated according to equation: $\log P = 15.0870 - 9\,839.59/(T + 273.75)$. † From (458); all other values from (66). Menzies (886) considers the values of (1325) more reliable than those of (458). ‡ From (1325).



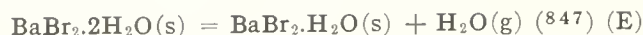
T	P	T	P
278.1	0.0071	283.1	0.0099



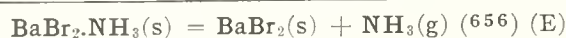
T	P	T	P
257.6	0.249	262.3	0.378
258.1	0.254	273.1	0.658
		$\Delta H = 72\,000$	



T	P	T	P
313.1	0.030	343.1	0.120
333.1	0.076	348.1	0.151
338.1	0.089		



T	P	T	P
293.1	0.0139	333.1	0.163



T	P	T	P
273.1	0.007	314.1	0.049
$\Delta H = 11\,800$			



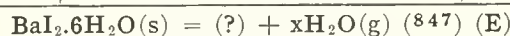
T	P	T	P
273.1	0.033	306.1	0.288
$\Delta H = 10\,600$			



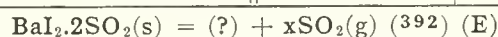
T	P	T	P
273.1	0.064	306.1	0.654
$\Delta H = 20\,400$			



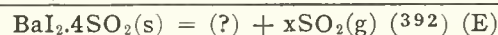
T	P	T	P
273.1	0.092	288.1	0.262
277.1	0.132	306.1	0.843
$\Delta H = 40\,000$			



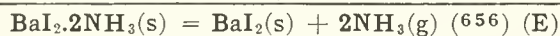
T	P	T	P
293.1	0.0108	333.1	0.079



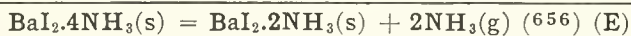
T	P	T	P
288.1	0.086	322.1	0.987
302.1	0.191	322.6	1.000 (extrap.)
314.1	0.513		$\Delta H = 11\,340\text{x}$



T	P	T	P
273.1	0.500	282.1	0.820
275.6	0.576	285.6	1.000 (extrap.)
280.1	0.737		$\Delta H = 9\,910\text{x}$



T	P	T	P
336.1	0.021	351.1	0.071
349.7	0.066		$\Delta H = 26\,800$



T	P	T	P
306.1	0.092	336.1	0.441
$\Delta H = 22\,600$			



T	P	T	P
273.1	0.018	306.1	0.132
$\Delta H = 22\,200$			



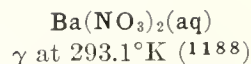
T	P	T	P
273.1	0.030	306.1	0.257
$\Delta H = 21\,400$			



T	P	T	P
273.1	0.179	306.1	0.566
$\Delta H = 10\,000$			

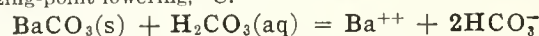


T	P	T	P
195.1	0.024	273.1	>1.111
$\Delta H = 7\,700$			

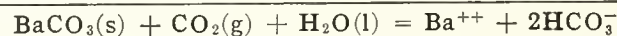


m	$-\log \gamma'$	γ'	θ^*	$a_{(\text{H}_2\text{O})}$
0.0005	0.0382	0.915	0.00271	0.999975
.001	.0536	.884	.00535	.999950
.002	.0741	.843	.01053	.999898
.005	.1133	.770	.02556	.999750
.01	.1541	.701	.04955	.999520
.02	.2074	.620	.09532	.999078
.05	.3002	.501	.22274	.997840
.1	.3898	.408	.41702	.995965
.2	.5030	.314	.76449	.992615

* θ = Freezing-point lowering, $^\circ\text{C}$.



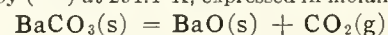
$$K_{298.1} = 3.63 \times 10^{-5}; \Delta F_{298.1}^0 = 6\,060 \quad (1191) \text{ from } (975)$$



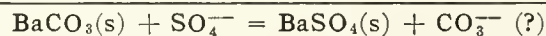
Log $p.f.$ _{298.1} = 1.952; $K_{298.1} = 1.39 \times 10^{-6}$; $\Delta F_{298.1}^0 = 7\,752$;
 $K_{298.1} = 0.92 \times 10^{-6}$; $\Delta H = -7\,860$; $\Delta F_{298.1}^0 = 8\,239 \quad (1191)$
 from (975); $K_{298.1} = 1.22 \times 10^{-6}$; $\Delta F_{298.1}^0 = 8\,070 \quad (1191)$ from
 (1319)

$c_{(\text{Ba}^{++})}$	$c_{(\text{HCO}_3^-)}$	p_{CO_2}	f_{CO_2}	$\mu_c^{1/2}$	$\log (1/K_c^{1/3})$
0.00601	0.001178	0.000504	0.000499	0.043	1.9257
.00732	.001444	.000808	.000800	.047	1.9063
.00117	.00232	.00333	.00333	.059	1.9064
.00196	.00392	.01387	.01373	.077	1.8862
.00255	.00510	.0282	.0279	.087	1.8747
.00312	.00624	.0499	.0495	.097	1.8700
.00464	.00928	.1417	.1403	.118	1.8485
.00578	.01156	.2529	.2504	.131	1.8369
.00690	.01380	.4217	.4175	.144	1.8341
.00766	.01532	.5529	.5474	.152	1.8279
.00843	.01686	.7292	.7220	.159	1.8263
.00941	.01882	.982	.973	.168	1.8217
.0137*	.0274	1.000	.990	.203	1.6611
.0299*	.0598	25.0	22.6	.299	1.7748

* Measurements by (564) at 291.1 $^\circ\text{K}$, expressed in molalities.



$\Delta H = 62\,200$, at room temperature; Hedvall (595) employing the not very accurate isothermal method, by the continued addition of heat, found $P = 1$ atmosphere at a temperature of 1634.1 $^\circ\text{K}$



$$K_{298.1} = \text{ca. } 25; \Delta F_{298.1}^0 = -1\,908; d_4^{25} \text{ given in original}$$

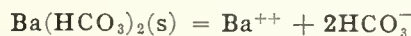
$m_{(\text{K}_2\text{SO}_4)}$	$m_{(\text{K}_2\text{CO}_3)}$	μ	K_m
$T = 298.1^\circ\text{K}$			
0.00331	0.0690	0.217	20.9
.01218	.1873	.598	15.4
.0580(s)	.5243	1.747	9.03
$T = 353.1^\circ\text{K}$			
0.01178	0.0604	0.217	5.13
.02756	.1223	.450	4.49
.1704(s)	.4630	1.900	2.72
$T = 373.1^\circ\text{K}$			
0.01533	0.0571	0.217	3.73
.03639	.1131	.448	3.11
.2279(s)	.4144	1.927	1.82

$\text{K}_2\text{SO}_4(\text{aq})$ and $\text{K}_2\text{CO}_3(\text{aq})$ by $\text{BaCl}_2(\text{aq})$; the solid phases may not be pure; $K_{298.1} = \text{ca. } 8$; $\Delta F_{298.1}^0 = \text{ca. } -1\,230 \quad (1167, 1168)$

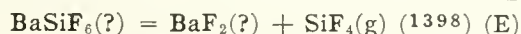
$c_{(\text{K}_2\text{SO}_4)}$	$c_{(\text{K}_2\text{CO}_3)}$	$c_{(\text{KCl})}$	μ_c	K_c
$T = 293.1^\circ\text{K}$				
0.0005	0.0072	0.00068	0.0238	14.5
.0009	.0068	.00068	.0238	7.6
.0028	.0164	.0017	.0593	5.9

BaCO₃(s) + SO₄²⁻—(Continued)

<i>c</i> (K ₂ SO ₄)	<i>c</i> (K ₂ CO ₃)	<i>c</i> (KCl)	<i>μ_c</i>	<i>K_c</i>
<i>T</i> = 293.1°K.—(Continued)				
0.0032	0.0160	0.0017	0.0593	5.0
.0147	.0619	.0068	.2366	4.2
.0159	.0607	.0068	.2366	3.8
.096	.287	.034	1.183	3.0
.104	.279	.034	1.183	2.7
<i>T</i> = 369.1°K				
0.083	0.300	0.034	1.183	3.6
.089	.294	.034	1.183	3.3



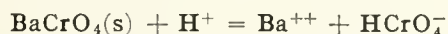
$K_{298.1} = 2.50 \times 10^{-5}$; $\Delta F_{298.1}^0 = 6\,282$ (1191) from (975); cf. (564)



$\log P = -30\,000/4.571T + 1.75 \log T + C$, where *C* is dependent upon *n**

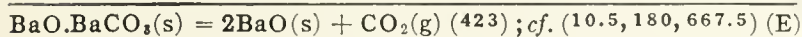
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
<i>n</i> * = 0.16			
942.6	0.0687	1 009.1	0.4913
962.6	0.1170	1 020.1	0.7092
1 008.1	0.4803	1 042.6	1.464
<i>n</i> * = 0.415			
960.1	0.0821	1 017.1	0.5039
995.1	0.2132	1 038.1	0.9280
1 008.1	0.3902	1 054.1	1.862
<i>n</i> * = 1.23			
932.6	0.0162	1 005.1	0.1995
952.6	0.0379	1 014.6	0.2735
987.6	0.1200	1 043.6	0.6426
992.1	0.1364	1 049.6	0.7257

* *n* = BaF₂/BaSiF₆.



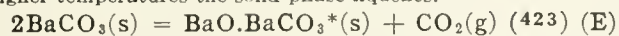
In HCl(aq) at 291.1°K (71)		In HCl(aq) 310.1°K (71)	
<i>c</i> (ΣH ⁺)	<i>c</i> (ΣCr)	<i>c</i> (ΣH ⁺)	<i>c</i> (ΣCr)
0.2	0.0251	0.1	0.0202
.3	.0355	.2	.0367
.4	.0443	.3	.0535
.5	.0548	.4	.0702
.6	.0662	.5	.0875
		.6	.106

In HNO ₃ (aq) at 291.1°K (806)		In HNO ₃ (aq) 310.1°K (806)	
<i>c</i> (ΣH ⁺)	<i>c</i> (ΣCr)	<i>c</i> (ΣH ⁺)	<i>c</i> (ΣCr)
0.2	0.0251	0.1	0.0202
.3	.0355	.2	.0367
.4	.0443	.3	.0535
.5	.0548	.4	.0702
.6	.0662	.5	.0875
		.6	.106



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 293.1	0.0025	1 523.1	0.0893
1 393.1	0.0137	1 727.1*	0.987
$\Delta H = 2\,100$			

* At higher temperatures the solid phase liquefies.

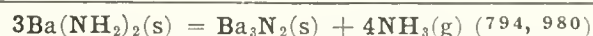
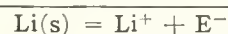
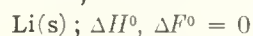


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 188.1	0.0005	1 293.1	0.0053
1 218.1	0.0011	1 318.1	0.0086
1 238.1	0.0016	1 343.1	0.0137
1 268.1	0.0032	1 368.1	0.0214
1 273.1	0.0036	1 373.1	0.0233

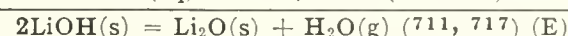
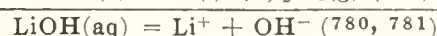
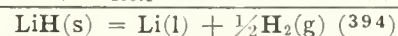
2BaCO₃(s).—(Continued)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
1 393.1	0.0330	1 528.1	0.272
1 418.1	0.0504	1 573.1	0.503
1 468.1	0.1116	1 623.1†	0.967
1 493.1	0.161	1 625.1	1.000
$\Delta H = 63\,200$			

* The resulting BaO·BaCO₃ can dissolve BaO as well as BaCO₃. † At higher temperatures the basic carbonate exists as a fused mass. Pure BaCO₃ melts at 1623.1°K.

**Li, Lithium**

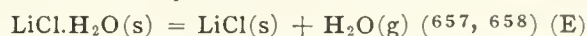
$E_{298.1}^0 = 2.9578$; $\Delta F_{298.1}^0 = -68\,248$ (885) from (870)



ΔH (calc.) = 24 000; ΔH (Thomsen) = 24 000

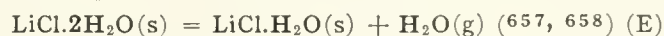
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
793.1	0.003	1 038.1	0.259
823.1	0.009	1 055.1	0.309*
834.1	0.012*	1 085.1	0.424
867.1	0.0229*	1 099.1	0.467*
883.1	0.030	1 119.1	0.546
935.1	0.072*	1 148.1	0.692*
943.1	0.082	1 156.1	0.729
973.1	0.121*	1 176.1	0.856
997.1	0.159	1 197.1	1.000*
1 013.1	0.196*		

* Interpolated according to equation: $\log P = 3.9t_w + 530$, where *t_w* = the temperature at which the pressure of pure water is equal to the pressure of the LiOH at the measured temperature.



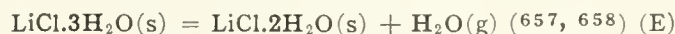
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
303.1	0.0005	333.1	0.008
308.1	0.0010	338.1	0.0116
313.1	0.0016	343.1	0.0153–0.0174
318.1	0.0021	373.6	0.118*
323.1	0.0037	375.1†	0.132†
328.1	0.0050	$\Delta H = 14\,630$	

* Quadruple point. † Extrapolated from (657); all other values from (658).



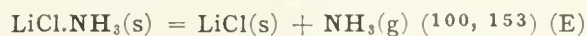
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.0005	285.6	0.003*
283.1	0.0016	338.1	0.132†
$\Delta H = 13\,700$			

* Quadruple point. † Extrapolated from (657); all other values from (658).



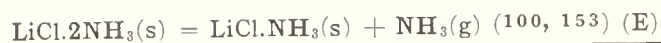
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
238.1	0.0003	256.6	0.0010*
244.1	0.0004	331.1	0.132†
248.1	0.0004	$\Delta H = 13\,600$ †	

* Quadruple point. † Extrapolated from (657); all other values from (658).
‡ Calculated according to the Nernst equation.



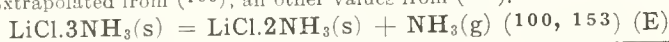
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
343.1	0.132*	382.3	0.850
361.1	0.337	392.1	1.283
369.1	0.483	$\Delta H = 12\,400$	

* Extrapolated from (100); all other values from (153).



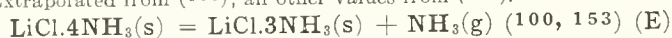
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
317.1	0.132*	356.1	0.972
341.9	0.491	372.3	1.289
350.1	0.734	$\Delta H = 11\,500 \text{ (100)}$	

* Extrapolated from (100); all other values from (153).



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
296.6	0.132*	333.1	1.040
305.9	0.233	335.3	1.161
316.1	0.421	338.1	1.330
323.1	0.622	$\Delta H = 10\,700 \text{ (100)}$	

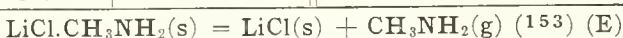
* Extrapolated from (100); all other values from (153).



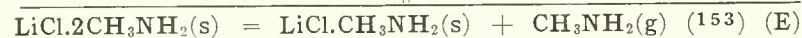
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.505	285.84	0.992
282.1	0.842	289.6	1.053
$\Delta H = 8\,800$			



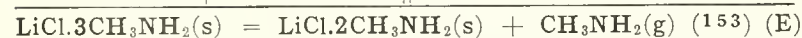
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
214.6	0.0326	228.1	0.116
223.1	0.076	$\Delta H = 8\,000$	



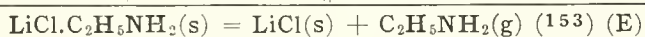
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
339.3	0.664	347.5	1.077
344.1	0.845	$\Delta H = 13\,800$	



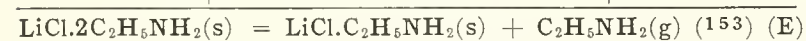
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
300.1	0.196	323.3	0.845
313.1	0.457	$\Delta H = 12\,100$	



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
295.5	0.380	313.6	1.088
308.1	0.789	$\Delta H = 10\,900$	



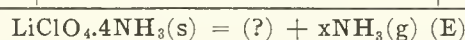
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
362.4	0.996	364.8	1.129
$\Delta H = 10\,500$			



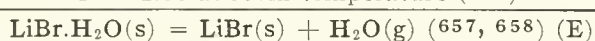
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
342.5	0.978	345.1	1.105
$\Delta H = 11\,100$			



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
330.1	0.916	334.1	1.107
$\Delta H = 10\,500$			

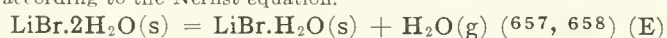


$P = 1.00$ at room temperature (385)

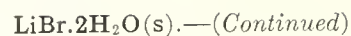


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
353.1	0.0024	413.1	0.132*
376.8	0.0122	432.1	0.300†
393.1	0.0343	$\Delta H = 17\,250†$	

* From (657), all other values from (658). † Quadruple point. ‡ Calculated according to the Nernst equation.

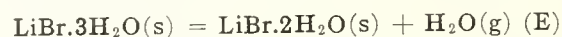


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
277.1	0.00018	301.1	0.0013
290.6–294.6	0.00079	303.1	0.0016
299.1	0.0010	305.1	0.0037†

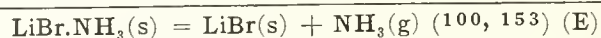


<i>T</i>	<i>P</i>	$\Delta H = 17\,730†$
359.1*	0.132	

* From (657); all other values from (658). † Quadruple point. ‡ Calculated according to Nernst equation.



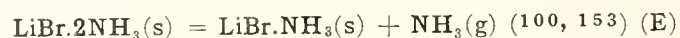
$P_{335.1} = 0.132 \text{ (657)}$



$\Delta H = 13\,600 \text{ (100)}; 13\,400 \text{ (153)}$

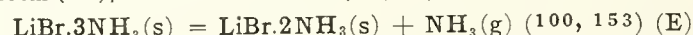
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
334.1	0.0138	368.6*	0.961
349.7	0.0349	370.6*	1.060
353.1	0.0428	372.1*	1.138†
365.1*	0.0826†	375.1	0.132†
366.1	0.0874	384.1	0.199

* From (153); all other values from (100); difficult to determine which are more accurate. † Extrapolated.



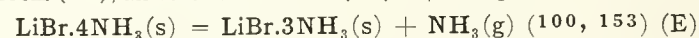
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
321.1*	0.132†	363.6	1.115
358.1	0.862	365.1	1.216†
360.6	0.976†	$\Delta H = 11\,800^*$	

* From (100); all other values from (153). † Extrapolated.



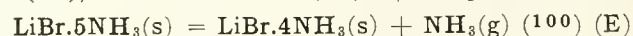
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
306.1*	0.132†	344.9	1.062
340.1	0.837	$\Delta H = 11\,100^*$	

* From (100); all other values from (153). † Extrapolated.

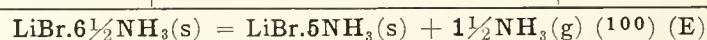


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1*	0.132†	331.1	1.000
327.1	0.812†	333.1	1.088
329.1	0.896	$\Delta H = 10\,200^*$	

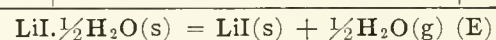
* From (100); all other values from (153). † Extrapolated.



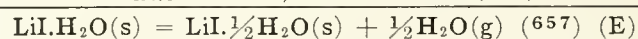
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
213.1	0.025	233.1	0.174
223.1	0.071	253.1	0.629
$\Delta H = 8\,050$			



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
194.6	0.047	213.1	0.207
$\Delta H = 10\,350$			

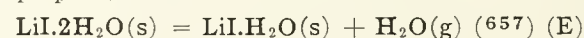


$P_{486.1} = 0.132; \Delta H = 10\,200 \text{ (657)}$



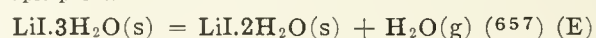
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
<403.1	0.0086*	451.1	0.132
$\Delta H = 9\,500$			

* Quadruple point.



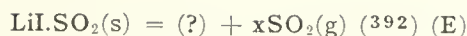
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
350.1	0.0059*	401.1	0.132 (extrap.)
$\Delta H = 16\,800$			

* Quadruple point.

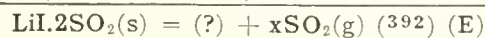


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
343.6	0.009*	385.1	0.132 (extrap.)
$\Delta H = 16\,000$			

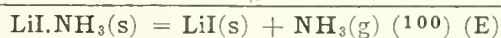
* Quadruple point.



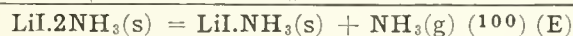
T	P	T	P
261.1	0.329	273.1	0.592
263.6	0.362	281.1	1.000 (extrap.)
265.6	0.382	$\Delta H = 9\,740\text{x}$	



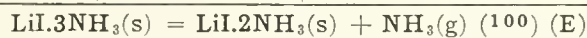
T	P	T	P
252.6	0.355	265.6	0.671
259.1	0.500	272.1	1.000 (extrap.)
261.6	0.553	$\Delta H = 9\,400\text{x}$	



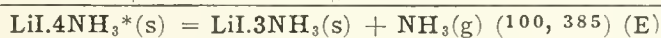
T	P	T	P
338.1	0.0112	408.1	0.0309
398.1	0.0195	$\Delta H = 16\,000$	



T	P	T	P
337.9	0.0132	363.1	0.054
351.3	0.0276	373.1	0.0821
353.1	0.0320	$\Delta H = 13\,800$	

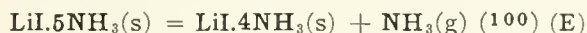


T	P	T	P
291.1	0.0068	329.1	0.0864
307.6	0.0221	337.9	0.140
319.1	0.0509	$\Delta H = 12\,200$	

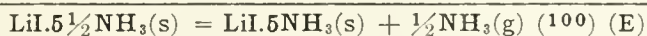


T	P	T^\dagger	P^\dagger
288.1†	0.008	338.1	0.214
307.6	0.030	348.1	0.408
319.1	0.061	356.1	0.638
329.1	0.103	360.1	0.804
334.6	0.133	363.1	0.979
337.9	0.159	$\Delta H = 11\,600 \text{ (}^{100}\text{)}$	

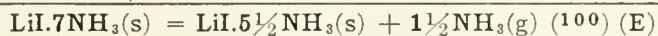
* According to ⁽³⁸⁵⁾ $\text{LiI} \cdot 4\text{NH}_3$ exists in an unstable form for which $P = 0.434$ at $T = 230.1^\circ\text{K}$. † From ⁽³⁸⁵⁾; all other values from ⁽¹⁰⁰⁾.



T	P	T	P
203.1	0.009	233.1	0.159
213.1	0.0266	253.1	0.661
223.1	0.067	$\Delta H = 8\,300$	



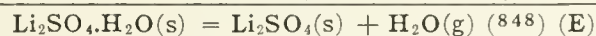
T	P	T	P
194.6	0.033	213.1	0.162
203.1	0.071	$\Delta H = 3\,600$	



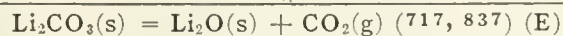
T	P	T	P
194.6	0.0386	213.1	0.197
203.1	0.092	$\Delta H = 10\,650$	



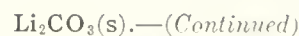
T	P	T	P
353.1	0.046	373.1	0.197



T	P	T	P
333.1	0.029	373.1	0.242
353.1	0.080	381.1	0.347

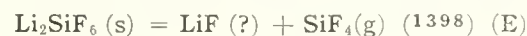


T	P	T	P
883.1*	0.0013	913.1	0.011
883.1	0.0013	983.1	0.021
893.1	0.004	996.1*	0.005



T	P	T	P
1 013.1	0.025	1 161.1*	0.042
1 043.1	0.030	1 163.1	0.067
1 058.1*	0.013	1 183.1*	0.054
1 073.1	0.038	1 203.1	0.080
1 083.1*	0.020	1 235.1*	0.083
1 103.1	0.045	1 273.1	0.120
1 113.1	0.049	1 283.1*	0.131
1 133.1	0.054	1 473.1	0.395
1 133.1*	0.029		

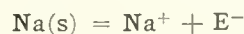
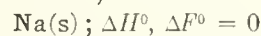
* From ⁽⁷¹⁷⁾; all other values from ⁽⁸³⁷⁾; difficult to determine which are more accurate.



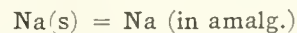
$$\log P = -25\,200/4.571T + 1.75 \log T + 0.01306T - 0.041766T^2 + 0.319$$

T	P	T	P
753.1	0.0399	836.1	0.9510
775.1	0.1104	844.1	1.036
791.1	0.2203	848.1	1.3037
812.1	0.3646	862.1	1.789
824.1	0.6713		

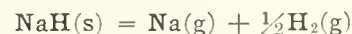
Na, Sodium



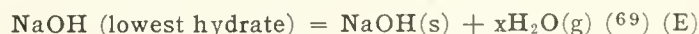
$$E_{298.1}^0 = 2.7125; \Delta F_{298.1}^0 = -62\,588 \text{ (}^{885}\text{) from (15, 1910)}$$



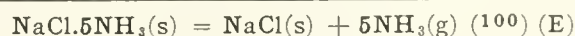
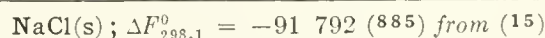
$$\% \text{Na} = 0.206, E_{298.1} = 0.8453 \text{ (}^{1910}\text{); cf. (1217)}$$



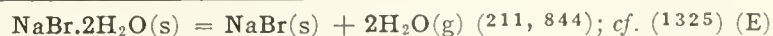
$$\log p = -5\,700/T - 2.5 \log T + 1.075 \text{ (}^{759}\text{)}$$



T	P	T	P
273.1	0.00005	323.1	0.00151
298.1	0.00020		

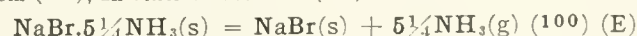


T	P	T	P
194.6	0.0094	223.1	0.145
213.1	0.053	249.1	1.022
$\Delta H = 39\,000$			

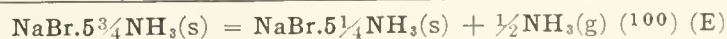


T	P	T	P
283.1	0.0045	293.1	0.01007
293.1*	0.00720	303.1	0.0204

* From ⁽²¹¹⁾; all other values from ⁽⁸⁴⁴⁾.



T	P	T	P
213.1	0.0108	233.1	0.0695
218.1	0.0179	243.1	0.158
$\Delta H = 44\,360$			

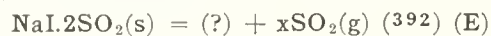


T	P	T	P
194.6	0.047	203.1	0.0953
$\Delta H = 3\,475$			

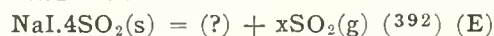


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
294.96*	0.00287	313.1	0.0118
302.90*	0.00514	323.1	0.022
303.1	0.0057	333.1	0.037
311.86*	0.00972		

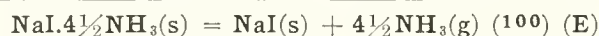
* From (526); all other values from (847).



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
253.1	0.096	276.1	0.500
261.6	0.145	280.1	0.629
265.6	0.237	284.6	0.809
268.1	0.276	288.1	0.987
273.1	0.404		$\Delta H = 10\,010\text{x}$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
271.1	0.671	278.1	1.000 (extrap.)
273.1	0.763		$\Delta H = 9\,650\text{x}$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
233.1	0.0084	263.1	0.0770
243.1	0.0172	273.1	0.162
253.1	0.0375		$\Delta H = 42\,300$

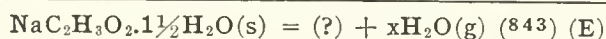


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
195.1	0.014	208.1	0.0522
200.1	0.024	213.1	0.078
203.1	0.0321	218.1	0.113
			$\Delta H = 11\,250$

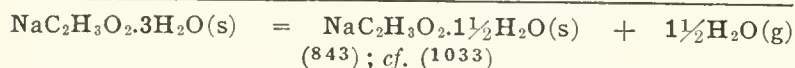
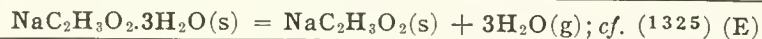


$$\log P = 16.7013 - 11\,042.9/(T + 290.1)$$

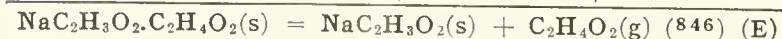
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
248.1	0.00014	293.1	0.00579
258.1	0.00036	298.1	0.00841
273.1	0.00118	303.1	0.01209
278.1	0.00183	308.1	0.01730
283.1	0.00271	313.1	0.02461
288.1	0.00399	323.1	0.04895
			$\Delta H = 26\,040$ (Thomsen)



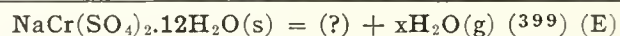
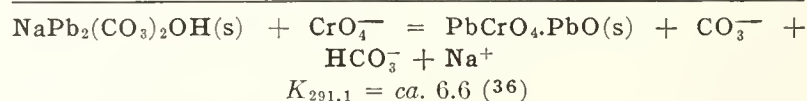
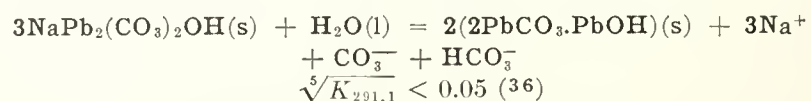
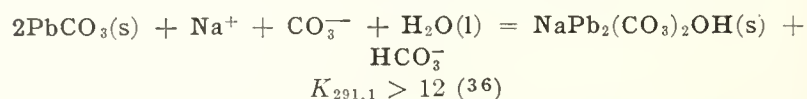
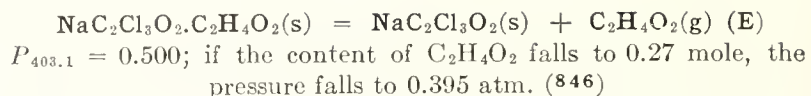
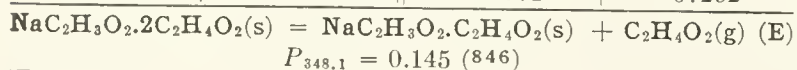
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.00270	303.1	0.0091
293.1	0.0047	308.1	0.0138



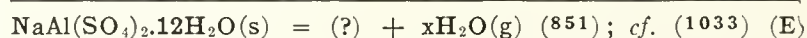
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.0032	308.1	0.0201
293.1	0.0058	313.1	0.0271
298.1	0.0091	323.1	0.0464
303.1	0.0138		



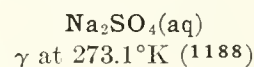
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
393.1	0.082	413.1	0.171
403.1	0.125	423.1	0.292



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
324.1	0.057	349.1	0.213
336.1	0.109	353.1	0.317
344.1	0.161	363.1	0.503

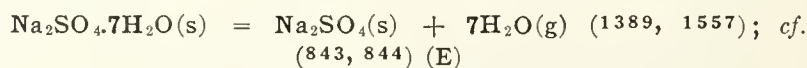


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
304.1	0.026	328.1	0.133
315.1	0.064	332.1	0.164
323.1	0.103		



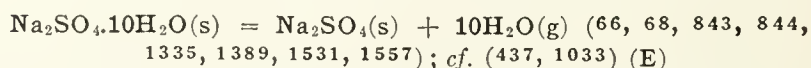
<i>m</i>	$-\log \gamma'$	γ'	θ^*	$a_{(\text{H}_2\text{O})}$
0.0005	0.0365	0.920	0.00271	0.999975
.001	.0507	.890	.00536	.999950
.002	.0701	.851	.01057	.999895
.005	.1060	.783	.02574	.999748
.01	.1433	.719	.05013	.999515
.02	.1903	.645	.09706	.999060
.05	.2701	.537	.22978	.997775
.1	.3482	.449	.43551	.995787
.2	.4276	.374	.85767	.991715

* θ = Freezing-point lowering, $^\circ\text{C}$.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1*	0.0174	296.7	0.0232
294.1	0.0188	297.0	0.0237
295.1	0.0203	297.2	0.0241
296.0	0.0218	297.5	0.0249

* From (1389); all other values from (1557).



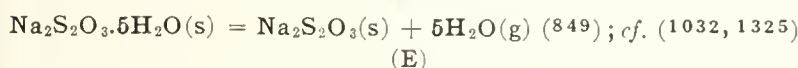
$\Delta H = 188\,000$ (Berthelot); $= 192\,600$ (Thomsen); $= 244\,000$ (1557) calculated from van't Hoff equation; $\log P = 7.685 - 2794.1/(T + 3)$ (68)

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1*	0.00368	294.7	0.0186
273.1†	0.0050	296.1	0.0207
278.1†	0.00684	297.2	0.0224
282.1	0.00689	298.1‡	0.02526
283.1†	0.0092	298.1§	0.02521
288.1†	0.01276	298.1	0.02529
293.1*	0.01743	298.1	0.0238
293.1†	0.0183	298.1†	0.0250
293.1	0.0164	299.0	0.0255

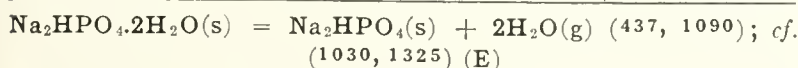
$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}(\text{s})$.—(Continued)

T	P	T	P
300.1	0.0276	302.6	0.0329
301.2	0.0299	304.1	0.0367
302.1†	0.0316	305.5	0.0405‡

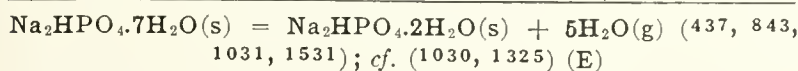
* From (66). † From (843, 844). ‡ From (68). § From (1335). || From (1557); all other values from (1389). ¶ Transition point.



T	P	T	P
288.1	0.0037	308.1	0.0154
293.1	0.0054	313.1	0.0238

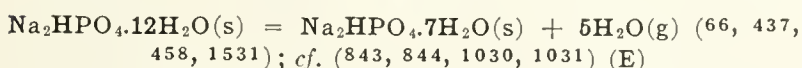


T (437)	P	T (1090)	P
298.1	0.0117	298.1	0.0128



T	P	T	P
273.1	0.0024	305.7*	0.0250
278.1	0.0036	308.1	0.0342
283.1	0.0051	313.1	0.0507
288.1	0.0075	329.2*	0.1042
290.6*	0.00837	330.9*	0.1146
293.1	0.01065	332.3*	0.1134
298.1	0.0157	333.1	0.149
298.1†	0.0163	333.2*	0.1229
298.1‡	0.01909	334.9*	0.1341
299.35*	0.0167	353.1	0.3579
299.7*	0.0176	372.1	0.784
303.1	0.0237		

* From (1031). † From (437). ‡ From (1531); all other values from (843).

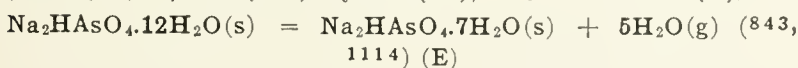


$$\Delta H = 56\,100 \text{ (Thomsen)}; = 112\,200 \text{ (458)}; \text{ cf. } (1325)$$

T	P	T	P
248.1	0.00037*	293.25†	0.01717
258.1	0.00095*	296.12†	0.02130
273.1	0.00350	298.1	0.00754
278.1	0.00530*	298.1‡	0.02517
279.90†	0.00607	298.1§	0.0237
283.1	0.00793*	300.10†	0.02840
283.92†	0.00839	303.1	0.01063
288.1	0.01175	308.1	0.01491
288.10†	0.01163	313.1	0.02076
290.38†	0.01385	323.1	0.03967
293.1	0.00532*		

* Calculated according to equation: $\log P = 11.2764 - 5\,172/(T + 103.63)$.

† From (458). ‡ From (1531). § From (437); all other values from (66).

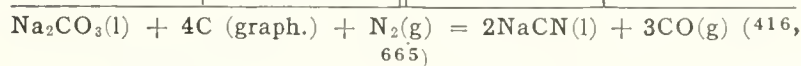


T	P	T	P
273.1	0.0013	303.1*	0.02006
278.1	0.0016	308.1*	0.02729
283.1	0.0028	313.1	0.0382
288.1	0.0045	333.1	0.101
293.1	0.0061	343.1	0.149
298.1	0.0129	353.1	0.247
298.1*	0.01461	373.1	0.558
303.1	0.0197		

* From (1114); all other values from (843)

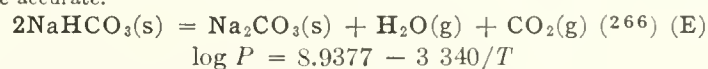
Lescœur (843) ascribes the above values to the 7-hydrate. He gives the following values for the change from the 12-hydrate to 7-hydrate:

T	P	T	P
273.1	0.0041	288.1	0.0151
278.1	0.0059	293.1	0.0211
283.1	0.0099		

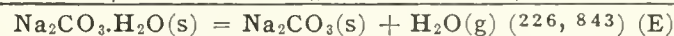


$\text{Na}_2\text{CO}_3(\text{s}) = \text{Na}_2\text{O}(\text{s}) + \text{CO}_2(\text{g}) \quad (837, 717) \quad (\text{E})$			
T	P	T	P
933.1*	0.0022	1 263.1	0.016
973.1	0.0013	1 283.1	0.018
1 003.1	0.0020	1 323.1	0.021
1 038.1*	0.0038	1 353.1	0.025
1 093.1	0.0039	1 373.1	0.028
1 130.1*	0.0051	1 423.1	0.037
1 153.1	0.013	1 453.1	0.050
1 193.1*	0.0061	1 473.1	0.054
1 248.1*	0.0075		

* From (717); all other values from (837); difficult to determine which are more accurate.



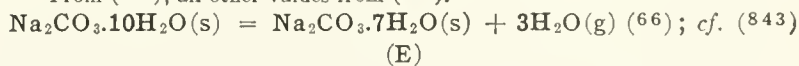
T	P	T	P
303.1	0.0082	373.1	0.9620
323.1	0.0395	380.5	1.4501
343.1	0.1584	383.1	1.6481
363.1	0.5451	384.8	1.8410
365.5	0.6151	388.6	2.1772



$$\Delta H = 13\,800; \log P = 7.944 - 3000.0/T$$

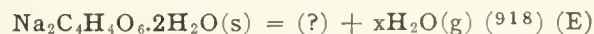
T	P	T	P
293.1*	0.0047	349.5	0.2192
303.6	0.0104	353.4	0.2843
313.5	0.0209	356.2	0.3202
324.1	0.0482	359.5	0.3909
330.2	0.0705	363.4	0.4781
339.5	0.1226	365.8	0.5525
343.2	0.1601	370.8	0.7093

* From (843); all other values from (266).



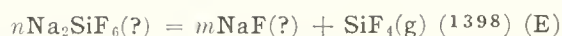
T	P	T	P
248.1	0.00038*	288.1	0.01146
258.1	0.00097*	293.1	0.01656*
273.1	0.00350	298.1	0.02369
278.1	0.00530*	305.12	0.03850*
283.1	0.00784*		

* Calculated according to equation: $\log P = 7.9263 - 3\,634.51/(T + 46.45)$.



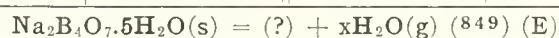
T	P	T	P
282.2	0.0099	303.1	0.0367*
285.8	0.0126	308.1	0.0488*
288.1	0.0145*	310.6	0.0563
290.3	0.0164	313.1	0.0643*
293.1	0.0200*	314.1	0.0688
295.1	0.0228	317.7	0.0820
296.6	0.0245	321.7	0.0995
298.1	0.0272*		

* Interpolated according to equation: $t = 1.00t_w + 2.3$, where t_w = the temperature at which water has the same pressure as the compound at the temperature, t .

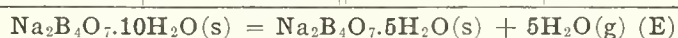


n = moles Na_2SiF_6 , m = moles NaF in solid phase; $\log P = -30\,600/4.571T + 1.75 \log T - 0.001823T + 0.319$

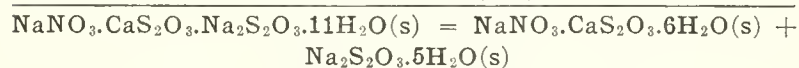
T	P	T	P
$n = 0.976; m = 0.024$		$n = 0.776; m = 0.224$	
989.1	0.0039	1 049.1	0.0136
1 098.1	0.0509	1 103.1	0.0517
1 202.1	0.3173	1 199.1	0.3177
1 225.1	0.4609	1 251.1	0.6110
$n = 0.511; m = 0.489$		$n = 0.330; m = 0.670$	
1 105.1	0.0559	1 171.1	0.1873
1 197.1	0.2842	1 234.1	0.5207
1 248.6	0.6137	1 251.6	0.6634
1 277.1	0.8405	1 320.1	1.1148
1 310.1	1.415	1 380.1	1.485
$n = 0.092; m = 0.908$			
1 158.1	0.1482	1 291.1	0.9044
1 220.1	0.4011	1 343.1	1.2601
1 256.1	0.6772		



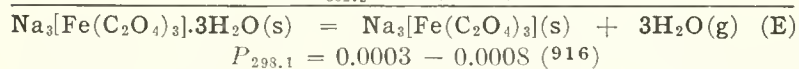
T	P	T	P
333.1	0.040	338.1	0.059



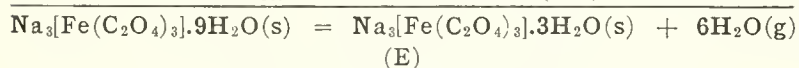
$$P_{293.1} = 0.01145 \quad (849)$$



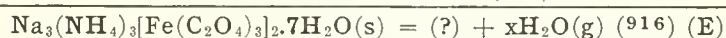
$$\Delta F_{302.2}^0 = 0 \quad (795.5)$$



$$P_{293.1} = 0.0003 - 0.0008 \quad (916)$$

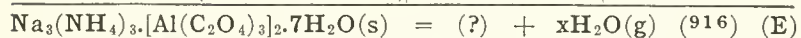


$$P_{298.1} = 0.0116 - 0.0176 \quad (916)$$



The first two molecules of water are lost continuously while the crystals remain clear. The next four molecules are evolved discontinuously and the crystals are turbid; over H_2SO_4 at 298.1°K

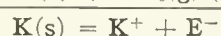
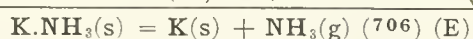
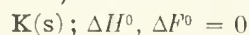
$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles	$P_{\text{H}_2\text{O}}$	Loss H_2O , Moles
0.02579	0.00	0.01161	0.97
0.02139	0.18	0.00593	2.00
0.01769	0.48	0.00230 to 0.00	5.98



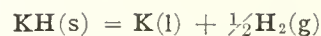
The first two moles of H_2O escape continuously, the crystals remaining clear; the next four moles escape while the crystals are turbid; over H_2SO_4 soln.

% H_2SO_4	Loss H_2O , Moles	
	283.1°K	296.1°K
10	Deliquescent	Deliquescent
20	0	Deliquescent
30	0.18	0
40	0.30	0.16
50	0.57	0.43
60	1.98	1.62
70	6.00	1.96
80	6.01	5.96
90	6.01	5.96
97	6.01	5.96

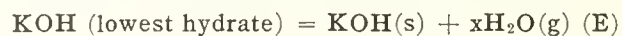
K, Potassium



$$E_{298.1}^0 = 2.2924; \Delta F_{298.1}^0 = -67\,431 \quad (885) \text{ from } (869)$$



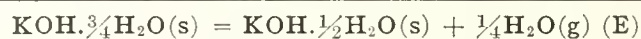
$$\log p = -5\,850/T + 2.6 \log T + 1.014 \quad (759)$$



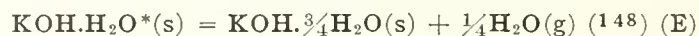
$$P_{323.1} = 0.000009 \quad (69)$$



$$P_{303.1} = 0.00 \quad (148)$$

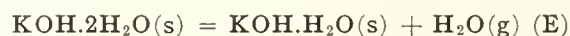


$$P_{304.85} = 0.00097 \quad (148)$$

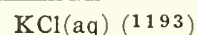


T	P	T	P
300.85	0.0020	314.85	0.00275

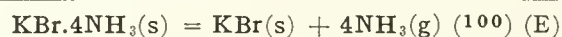
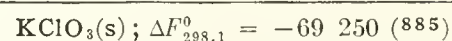
* $\text{KOH} \cdot \text{H}_2\text{O}$ dissolves $\text{KOH} \cdot \frac{3}{4}\text{H}_2\text{O}$ in very small amounts, therefore the dissociation pressure does not diminish abruptly at the transition point, but diminishes continuously over a very small interval. The same holds for $\text{KOH} \cdot \frac{3}{4}\text{H}_2\text{O}$, which can absorb $\text{KOH} \cdot \frac{1}{2}\text{H}_2\text{O}$ in small amounts.



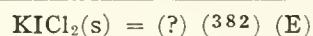
$$P_{300.85} = 0.00475 \quad (148)$$



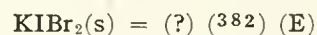
m	$\gamma_{293.1}$	m	$\gamma_{293.1}$
0.1	0.772	1.0	0.601
.2	.715	2.0	.570
.5	.651		



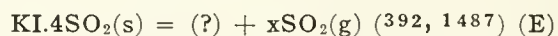
T	P	T	P
194.6	0.0366	213.1	0.179
208.1	0.120	$\Delta H = 28\,600$	



T	P	T	P
314.1	0.037	375.1	0.384
331.1	0.076	385.1	0.509
344.6	0.150	395.1	0.664
352.6	0.201	404.1	0.816
363.1	0.276	409.1	0.926

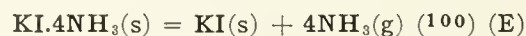


T	P	T	P
290.1	0.007	344.1	0.129
313.1	0.020	353.1	0.184
327.6	0.062		

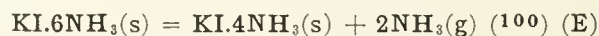


T	P	T	P
252.1	0.146	274.6	0.680
261.1	0.184	278.1	0.796
273.1	0.649	278.6	0.836
273.36*	0.657	279.6	0.895
$\Delta H = 9\,670x$			

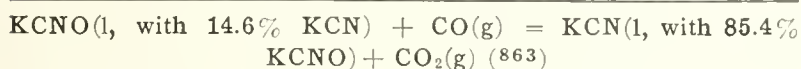
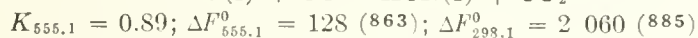
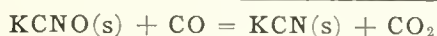
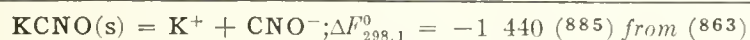
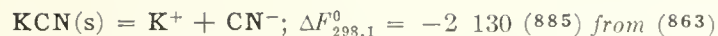
* From (1487); all other values from (392).



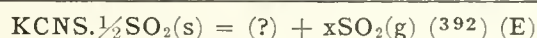
T	P	T	P
186.1	0.010	213.1	0.0467
203.1	0.0195	218.1	0.070
208.1	0.0309	$\Delta H = 30\,600$	



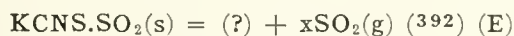
T	P	T	P
194.6	0.020	203.1	0.397
$\Delta H = 14\,700$			



<i>T</i>	<i>K</i>	<i>T</i>	<i>K</i>
721	(1.86)	816	2.22
724	(1.92)	823	2.28
770	1.98	840	2.35
774	1.98	840	2.29
776	1.97	841	2.26
778	2.03	846	2.46
780	2.06	847	2.33
781	1.99		



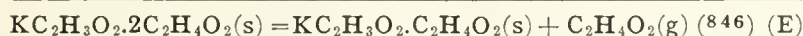
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.033	312.6	0.526
282.6	0.071	314.9	0.654
283.6	0.079	320.1	0.912
286.6	0.103	322.1	0.980
296.1	0.195		$\Delta H = 11\,310x$



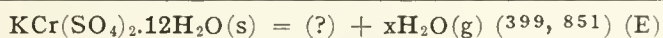
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
252.1	0.112	279.6	0.678
273.1	0.470	285.1	0.993
278.1	0.632	286.1	1.026
			$\Delta H = 9\,910x$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
433.1	0.016	453.1	0.092
443.1	0.042		

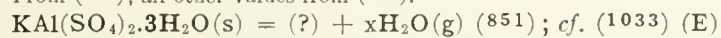


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
333.1	0.079	373.1	0.171
353.1	0.132		

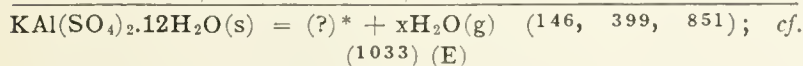


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
283.1*	0.0049	323.1	0.083
288.1*	0.0079	328.1	0.113
293.1*	0.0120	333.1	0.157
298.1*	0.0162	339.1	0.222
303.1*	0.0220	343.1	0.266
304.1	0.020	346.1	0.295
308.1*	0.0313	352.1	0.342
313.1	0.041		

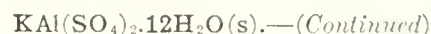
* From (851); all other values from (399).



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
303.1	0.0013	373.1	0.167
343.1	0.036	388.1	0.421
363.1	0.111		



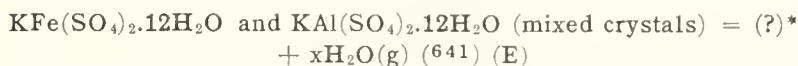
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
293.1	0.0061	316.1†	0.0201
303.1	0.00849	323.1†	0.024
306.1†	0.0114	328.1	0.0953



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
330.1†	0.0529	343.1‡	0.136
333.1‡	0.067	343.1	0.163
333.1	0.129	348.1	0.276
338.1	0.168	350.1†	0.2198
340.1	0.1116	353.1‡	0.263

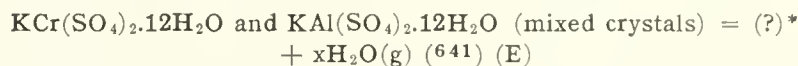
* According to (851) and (1033) the decomposition goes to the trihydrate; (146), however, found at 3.2 moles H₂O, $P = 0.1356$ at $T = 350.1$; (399) found for 9 moles H₂O, that the vapor pressure diminished only a little; e.g., $P = 0.057$ at $T = 333.1$, and $P = 0.232$ at $T = 353.1$.

† From (146). ‡ From (399); all other values from (851).



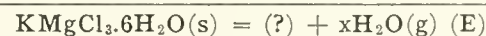
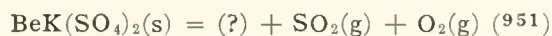
Mole % Fe-alum	<i>P</i> at $T = 293.1 \pm 0.2$	Mole % Fe-alum	<i>P</i> at $T = 293.1 \pm 0.2$
0.0	0.0026	62.4	0.0086
4.0	0.0022	71.8	0.0106
7.8	0.0020	78.1	0.0103
15.2	0.0018	89.0	0.0106
24.6	0.0021	98.2	0.0130
39.3	0.0028	100.0	0.0143
54.9	0.0051		

* From the maximum in the vapor-pressure curve Hollman deduces a compound containing 2 moles Fe-alum and 1 mole of Al-alum.

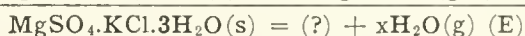
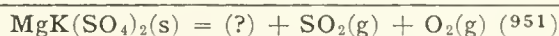


Mole % Cr-alum	<i>P</i> at $T = 293.1 \pm 0.2$	Mole % Cr-alum	<i>P</i> at $T = 293.1 \pm 0.2$
0.0	0.0026	63.2	0.0071
2.3	0.0022	71.8	0.0088
17.2	0.0020	78.8	0.0077
28.9	0.0020	87.4	0.0089
41.1	0.0026	95.3	0.0134
53.3	0.0044	100.0	0.0174

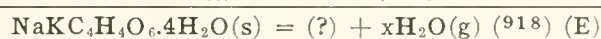
* Hollman deduces a compound of 2 moles Cr-alum to 1 mole of Al-alum.



$$P_{305.45} = 0.0013 \text{ (148)}$$

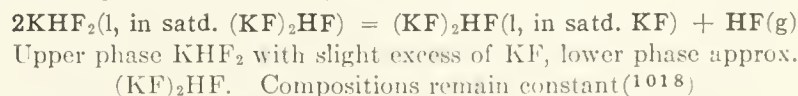


$$P_{305.45} = 0.0013 \text{ (148)}$$

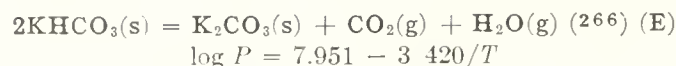


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1	0.0054*	302.8	0.0176
291.1	0.0072	303.1	0.0178*
293.1	0.0083*	303.2	0.0180
294.5	0.0093	308.1	0.0253*
297.1	0.0113	308.2	0.0258
298.1	0.0122*	313.1	0.0366*
298.2	0.0122		

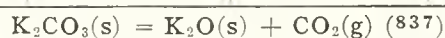
* Interpolated according to equation: $t = 0.881t_w + 16.0$.



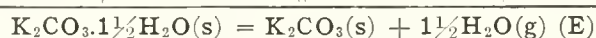
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
503.6	0.0659	531.6	0.1045
506.1	.0654	539.1	.1269
515.1	.0828	554.1	.1581
521.1	.0814	567.1	.2198
526.6	.0953	610.6	.3480
530.1	.0993		



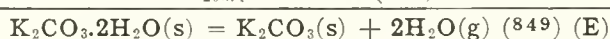
T	P	T	P
340.8	0.0054	411.5	0.4247
349.4	0.0150	419.4	0.6203
363.3	0.0324	420.9	0.6620
365.6	0.0411	424.9	0.8034
376.6	0.0759	426.5	0.8725
389.5	0.1463	428.5	0.9392
392.2	0.1633	429.1	0.9645
400.3	0.2527		



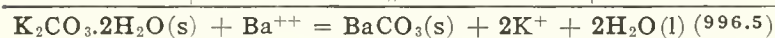
T	P	T	P
1003.1	0.000	1233.1	0.007
1063.1	0.0007	1243.1	0.012
1083.1	0.0013	1273.1	0.016
1163.1	0.004	1363.1	0.022



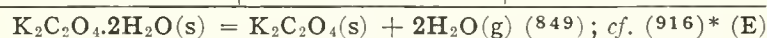
$$P_{298.1} = 0.0014 \quad (430)$$



T	P	T	P
363.1	0.075	383.1	0.226
373.1	0.132	393.1	0.362



T	$m(\text{K}_2\text{CO}_3)$	$m(\text{K}_2\text{SO}_4)$
298.1	2.663	0.000918



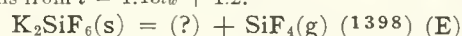
T	P	T	P
323.1	0.026	353.1	0.091
333.1	0.030	363.1	0.174
343.1	0.054	373.1	0.283

* According to Lowenstein (916), the decomposition results in the monohydrate as an intermediate product. At 298.1°K, for the compound $\text{K}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, $P = 0.0024$ to 0.0058 ; for the compound $\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$, $P = 0.0008$ to 0.0024 .

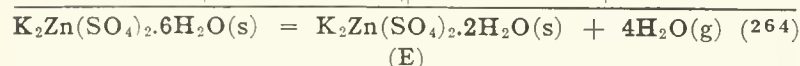


T	P	T	P
287.3	0.0132	298.1	0.0241*
288.1	0.0138*	300.4	0.0267
291.6	0.0171	303.1	0.0313
293.1	0.0183*	305.1	0.0337
293.2	0.0184	308.1	0.0404*
294.8	0.0195	308.5	0.0403
297.0	0.0216	313.1	0.0525

* Interpolations from $t = 1.15t_w + 1.2$.



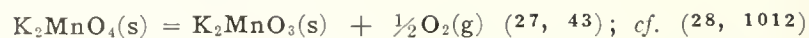
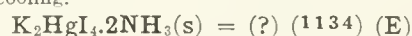
T	P	T	P
1248.1	0.0308	1398.1	0.2423
1299.1	0.0439	1420.1	0.5293
1349.1	0.0968	1453.1	1.512
1383.1	0.1780		



$$\log P = 7.953 - 2992/T$$

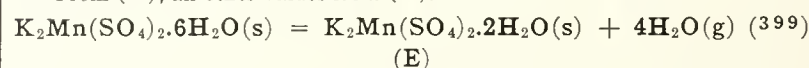
T	P	T	P
289.3	0.0047*	322.3	0.0450
309.0	0.0186	325.4	0.0584*
311.2	0.0213*	330.3	0.0784
311.8	0.0218	336.5	0.1146
318.5	0.0359*		$\Delta H = 55200$

* Measured on cooling.

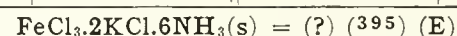


T	P	T	P
683.1*	0.003	883.1	0.1822
727.1*	.007	887.1	.2030
776.1	.0084	889.1*	.310
780.1	.0145	891.1	.2224
786.1	.0174	902.1	.2908
789.1	.0199	904.1	.3079
816.1	.0359	906.1	.3201
821.1*	.053	915.1	.3868
834.1	.0538	925.1*	.747
845.1	.0692	926.1	.5020
850.1	.0789	934.1	.617
859.1*	.143	940.1	.700
873.1	.1444	941.1*	1.005
879.1	.1632		

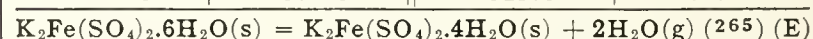
* From (27); all other values from (43).



T	P	T	P
328.1	0.133	353.1	0.430
335.1	0.195	358.6	0.549
340.6	0.245	364.1	0.670
345.1	0.303	368.1	0.780
350.1	0.388	372.1	0.896



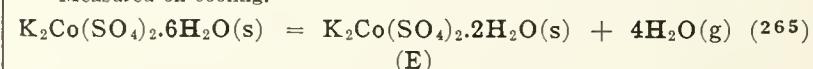
T	P	T	P
273.1	0.171	299.6	0.592
287.1	0.362	305.1	0.737
293.6	0.480	313.6	0.947



$$\log P = 3.887 - 866.5/T - 244400/T^2$$

T	P	T	P
298.2	0.0276	324.3	0.1203
299.7	0.0311	328.8	0.1490
305.6	0.0433	334.8	0.1955
312.1	0.0636*	339.7	0.2458
318.1	0.0880	344.6	0.3012
323.8	0.1291		$\Delta H = 20800$

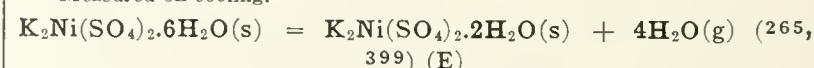
* Measured on cooling.



$$\log P = 3.853 - 265.7/T - 451350/T^2$$

T	P	T	P
299.6	0.0095	327.1	0.0704*
300.7	0.0109*	330.1	0.0845
305.9	0.0153	333.7	0.1074
312.7	0.0253	339.3	0.1491*
318.8	0.0403	339.4	0.1505
324.2	0.0582	349.4	0.2649
			$\Delta H = 56000$

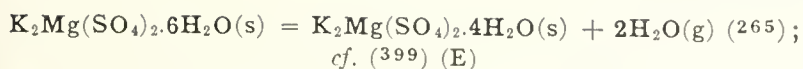
* Measured on cooling.



$$\log P = -1.900 + 3329/T - 1039000/T^2$$

T	P	T	P
306.9	0.0082	333.9	0.0563*
318.2	0.0192	339.6	0.0784*
321.7	0.0255*	349.3	0.1291
328.9	0.0411	370.1†	0.151
			$\Delta H = 56400$

* Measured on cooling. † From (399); all other values from (265).



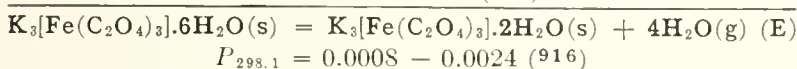
$$\log P = 3.982 - 908.3/T - 221.950/T^2$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.9	0.1153	330.4	0.1583*
327.4	0.1367	318.0	0.0846*
333.4	0.1822	309.3	0.0529*
338.0	0.2253	300.3	0.0322*
343.5	0.2856	$\Delta H = 20.800$	

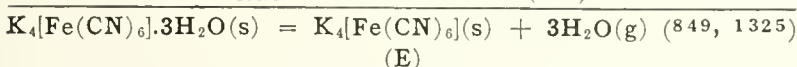
* Measured on cooling.



$$P_{298.1} = 0-0.0007 \quad (916)$$

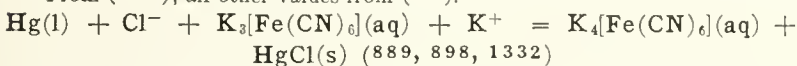


$$P_{298.1} = 0.0008 - 0.0024 \quad (916)$$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
288.1*	0.0070	303.1*	0.0193
293.1	0.0094	333.1	0.145
293.1*	0.0096	343.1	0.224
298.1*	0.0134	353.1	0.368

* From (1325); all other values from (849).

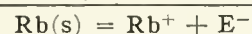


$m_{(\text{KCl})} \quad (898)$	$E_{298.1}^0$	$m_{(\text{KCl})} \quad (898)$	$E_{298.1}^0$
0.050	0.2269	1.572	0.2187
.100	.2209	2.007	.2192
.500	.2187	3.320	.2190
1.031	.2184	4.284	.2188

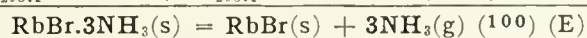
$m_{(\text{KCl})} \quad (889)$	$E_{298.1}^0$	$m_{(\text{KCl})} \quad (889)$	$E_{298.1}^0$
0.05	0.2264	0.4	0.2190
.1	.2217	.8	.2184
.2	.2190		

$m_{(\text{KCl})} \quad (1322)$	$E_{298.1}^0$	$m_{(\text{KCl})} \quad (1322)$	$E_{298.1}^0$
0.005	0.2776	0.200	0.2310
.010	.2693	.250	.2279
.025	.2507	.300	.2234
.050	.2401	.400	.2260
.100	.2322		

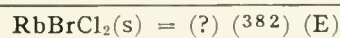
Rb, Rubidium



$$E_{298.1}^0 = 2.9242; \Delta F_{298.1}^0 = -67.473 \quad (885) \text{ from } (861)$$



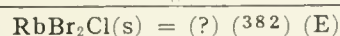
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
194.6	0.0454	203.1	0.0809
$\Delta H = 21.300$			



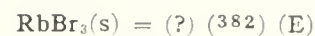
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
First form			
290.1	0.026	356.6	0.599
330.1	0.099	364.6	0.920
345.6	0.309	366.1	1.000

Second form

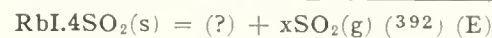
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
334.3	0.204	365.1	0.895
355.1	0.487		



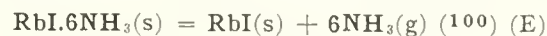
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
291.1	0.039	350.1	0.737
323.1	0.105	353.1	0.921
335.1	0.316	354.1	1.000
342.1	0.447		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
336.1	0.115	373.2	0.743
356.1	0.325	374.6	0.800
366.3	0.542	378.6	1.000



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.380	285.6	0.829
278.1	0.530	286.6	0.882
282.1	0.684	288.6	1.000 (extrap.)
283.9	0.759	$\Delta H = 10.030x$	



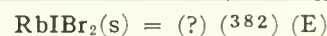
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
194.6	0.017	203.1	0.041
$\Delta H = 45.000$			



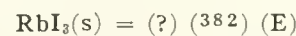
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
First form			
370.1	0.105	407.1	0.530
382.1	0.192	424.1	1.000 (extrap.)
393.1	0.309		

Second form

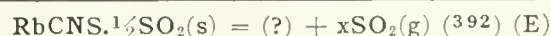
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
385.1	0.039	451.1	0.461
405.1	0.101	459.1	0.645
424.1	0.187	467.1	0.822
439.1	0.322		



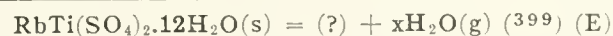
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
379.1	0.059	438.1	0.507
398.6	0.146	447.6	0.664
410.1	0.213	453.1	0.789
420.1	0.303	459.6	1.000
429.1	0.395		



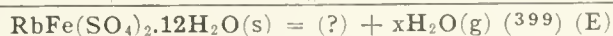
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
439.1	0.395	455.1	0.678
446.6	0.495	465.1	1.000 (extrap.)



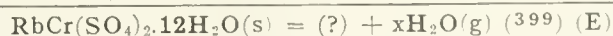
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
273.1	0.097	292.1	0.382
284.6	0.216	304.6	1.000 (extrap.)
$\Delta H = 10.640x$			



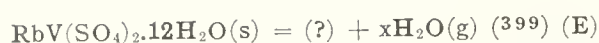
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
313.1	0.009	353.1	0.201
323.1	0.024	363.1	0.353
333.1	0.057	373.1	0.691
344.1	0.117	378.1	0.921



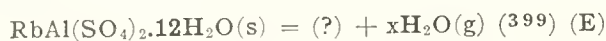
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
298.1	0.005	321.1	0.079
306.1	0.020	329.1	0.150
314.1	0.043		



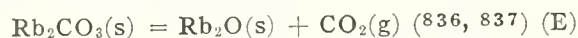
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
313.1	0.033	344.1	0.218
324.1	0.055	357.1	0.467
334.6	0.113	363.1	0.545



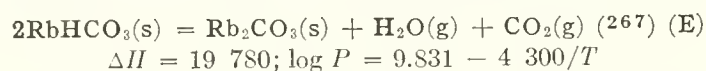
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
326.1	0.070	354.1	0.399
334.6	0.121	363.6	0.588
345.6	0.264		



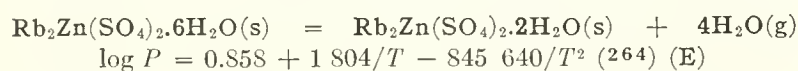
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.1	0.038	363.1	0.354
333.1	0.059	368.1	0.476
343.1	0.109	370.1	0.517
353.1	0.196		



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
936.1	0.000	1 173.1	0.013
1 013.1	0.003	1 263.1	0.024
1 103.1	0.008	1 293.1	0.026
1 143.1	0.011	1 353.1	0.043

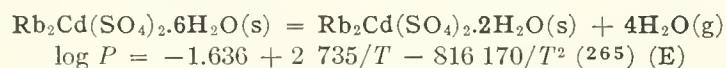


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
379.6	0.0678	425.0	0.5341
384.5	0.100	426.6	0.5872
393.2	0.128	431.7	0.7400
409.6	0.2857	434.1	0.8207
419.9	0.4251	437.1	0.9868
420.2	0.4514	443.7	1.3663



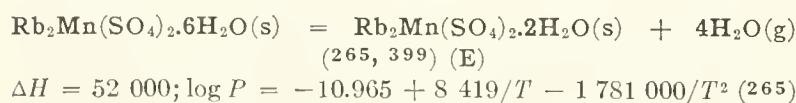
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
306.4	0.0047	337.8	0.0605
314.3	0.0104	339.3	0.0680*
319.9	0.0175*	343.3	0.0855*
320.7	0.0179	350.6	0.1318
328.4	0.0329*	354.6	0.1646
328.7	0.0332		$\Delta H = 62\,000$

* Measured on cooling.



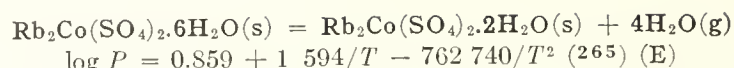
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
301.1	0.0304	334.8	0.1875
307.7	0.0461	340.6	0.2427
313.2	0.0629	320.3	0.0916*
318.6	0.0841	311.0	0.0561*
324.0	0.1120	305.7	0.0411*
329.5	0.1469		$\Delta H = 42\,000$

* Measured on cooling.



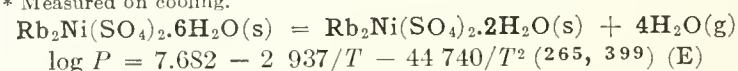
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
300.6*	0.0220	339.1	0.239
307.5*	0.0378	343.8*	0.2850
314.1*	0.0603	348.1 \setminus	0.355
319.8*	0.0887	357.1	0.493
326.5*	0.1296	363.1	0.629
328.1	0.136	368.1	0.757

* From (265); all other values from (399).



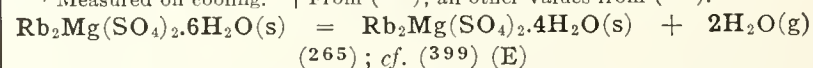
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
300.5	0.0054*	325.7	0.0354
301.3	0.0057	326.4	0.0379*
306.4	0.0089	332.0	0.0549
308.9	0.0105*	338.2	0.0788
311.5	0.0118	349.2	0.1476
318.4	0.0214		$\Delta H = 57\,600$

* Measured on cooling.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
305.6	0.0039	347.9	0.0733
307.5	0.0046*	348.1†	0.0711
313.2	0.0072	363.1†	0.103
322.7	0.0138	378.1†	0.168
325.0	0.0170*	383.1†	0.207
331.4	0.0262	388.1†	0.251
340.2	0.0463*		$\Delta H = 57\,600$

* Measured on cooling. † From (399); all other values from (265).

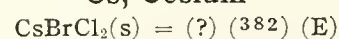


$$\Delta H = 20\,800; \log P = 4.871 - 1\,148/T - 264\,030/T^2$$

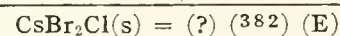
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
304.5	0.0178	330.5	0.0928*
317.0	0.0416	319.4	0.0470*
340.0	0.1617	301.9	0.0151*

* Measured on cooling.

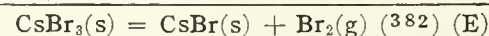
Cs, Cesium



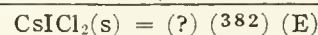
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
352.1	0.059	405.6	0.805
372.1	0.164	408.4	0.895
385.1	0.300	411.1	1.000
397.6	0.553		



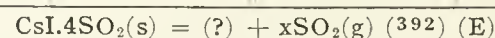
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
327.1	0.020	387.1	0.634
350.1	0.118	393.1	0.821
364.1	0.224	395.6	0.901
377.1	0.417	397.1	1.000



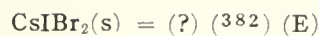
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
364.9	0.087	411.6	0.717
382.6	0.204	416.6	0.862
404.1	0.509	420.6	1.000



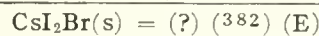
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
385.1	0.032	466.1	0.599
407.1	0.092	472.6	0.730
420.1	0.136	477.6	0.842
430.1	0.184	479.1	0.895
439.1	0.243	480.1	0.928
442.1	0.267	482.1	1.000
451.6	0.359		



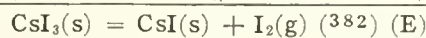
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
252.6	0.092	285.6	0.776
261.6	0.171	289.1	0.934
272.6	0.329	290.1	1.000 (extrap.)
279.1	0.513		$\Delta H = 10\,890\text{x}$



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
430.1	0.059	492.1	0.450
443.1	0.112	504.1	0.666
462.6	0.211	508.1	0.789
479.1	0.316	515.6	1.000

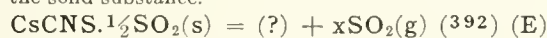


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
445.1	0.382	468.6 M. P.	0.816
455.6	0.520	473.1	0.862
464.1	0.672	474.6	1.000 (extrap.)

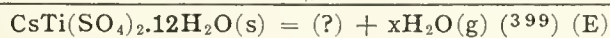


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
333.2*	0.0000395	470.1	0.147
353.1*	0.000256	479.1†	0.211
432.1	0.026	488.1	0.254
444.1	0.051	499.1	0.322
458.1	0.091	510.1	0.454
463.1	0.113	(523.1)	(1.0)‡

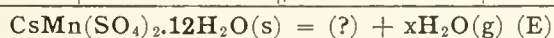
* From (1045). † The compound melts at $T = 480.6$. ‡ Extrapolation of the curve of the solid substance.



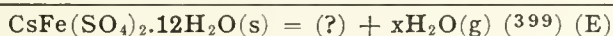
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
257.6	0.164	284.6	0.678
273.1	0.408	292.1	0.967
282.6	0.618		$\Delta H = 10\,140\text{x}$



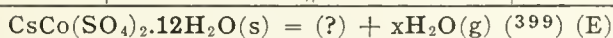
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
298.1	0.009	334.1	0.192
303.1	0.018	345.1	0.321
311.1	0.041	353.1	0.455
318.1	0.072	363.1	0.679
325.1	0.109	368.1	0.807



$$P_{302.1} = 0.018 \text{ (399)}$$

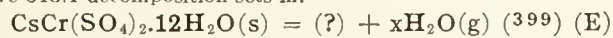


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
313.1	0.024	353.1	0.487
325.1	0.074	363.1	0.704
335.1	0.184		

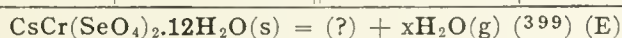


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
300.1	0.005	312.1*	0.033

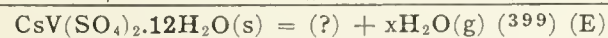
* Above 313.1 decomposition sets in.



<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
287.1	0.018	368.1	0.674
344.9	0.157	370.1	0.721
353.1	0.295	376.1	0.934
363.1	0.541		

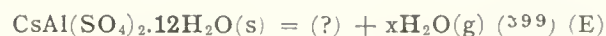


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.1	0.020	353.1	0.272
334.1	0.074	363.1	0.487
345.1	0.157	368.1	0.607

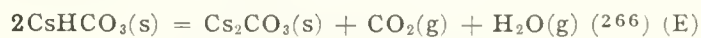


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.1	0.033	352.1	0.287
333.1	0.088	359.1*	0.428
344.1	0.183	363.1	0.543

* Decomposition begins.

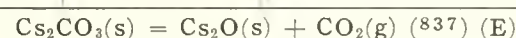


<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
323.1	0.017	368.1	0.362
334.1	0.043	373.1	0.488
348.1	0.124	378.1	0.624
358.1	0.209		

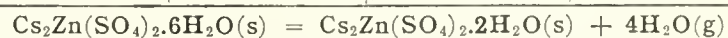


$$\log P = 14.049 - 6\,300/T$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
376.1	0.0379	439.1	0.5260
391.0	0.0625	443.0	0.6607
406.2	0.1041	445.3	0.7891
413.1	0.1325	450.1	1.1146
424.7	0.2222	451.2	1.2041
431.2	0.3089	452.9	1.3678
436.1	0.4248		$\Delta H = 28\,980$



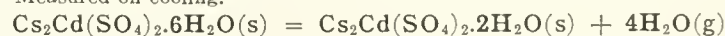
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
883.1	0.003	1\,273.1	0.058
953.1	0.005	1\,323.1	0.083
1\,078.1	0.008	1\,366.1	0.118
1\,133.1	0.011	1\,403.1	0.159
1\,163.1	0.016	1\,423.1	0.181
1\,253.1	0.042	1\,453.1	0.207



$$\log P = -1.148 + 3\,135/T - 1\,059\,800/T^2 \text{ (264) (E)}$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
307.5	0.0071*	326.5	0.0332
307.5	0.0078	332.9	0.0505
314.1	0.0122	333.9	0.0541*
317.4	0.0167*	343.8	0.1005
319.8	0.0197		$\Delta H = 62\,400$

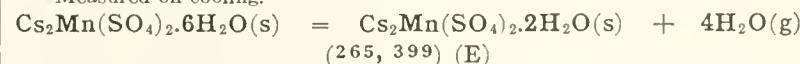
* Measured on cooling.



$$\Delta H = 42\,400; \log P = 1.878 + 471.2/T - 449\,370/T^2 \text{ (265) (E)}$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
298.8	0.0226	324.9	0.111
305.1	0.0371	334.1	0.1712
307.6	0.0416	337.5	0.1989
313.3	0.0607	321.5	0.0950*
319.2	0.0826	306.7	0.0397*

* Measured on cooling.

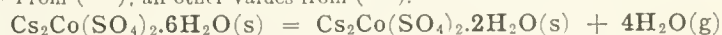


$$\text{ (265, 399) (E)}$$

$$\log P = -0.051 + 2\,263/T - 830\,860/T^2 \text{ (265)}$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
301.6*	0.0183	340.1	0.225
309.5*	0.0314	350.1	0.347
316.9*	0.0522	358.1	0.476
324.8*	0.0918	363.1	0.589
328.9*	0.1162	369.1	0.741
329.1	0.118	374.1	0.889
338.5*	0.2004		$\Delta H = 53\,200^*$

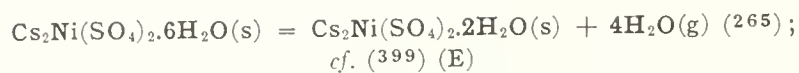
* From (265); all other values from (399).



$$\Delta H = 57\,200; \log P = 5.283 - 1\,221/T - 313\,270/T^2 \text{ (265) (E)}$$

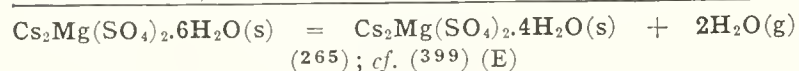
<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
302.3	0.0067	326.9	0.0412
314.1	0.0160	331.9	0.0579*
316.2	0.0197*	333.3	0.0626
320.1	0.0258	339.3	0.0926
324.7	0.0349*	348.1	0.1559

* Measured on cooling.



$$\Delta H = 53\,600; \log P = -4.611 + 4\,798/T - 1\,249\,600/T^2$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
308.1	0.0063	329.0	0.0249
317.3	0.0118	338.8	0.0466
321.8	0.0166	355.1	0.0989

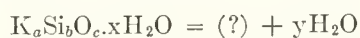


$$\Delta H = 50\,800; \log P = 3.716 - 751.8/T - 260\,600/T^2$$

<i>T</i>	<i>P</i>	<i>T</i>	<i>P</i>
303.1	0.0249	330.1	0.1116
309.7	0.0370	340.8	0.1833
321.8	0.0725	326.3	0.0908*

* Measured on cooling.

DEHYDRATION BEHAVIOR OF MINERALS (E)



Potassium Silicate Hydrate

The results of the detailed work of Morey (1016) cannot be interpreted in a short abstract.

Kaolin

The results of Tammann and Pape (1424) cannot be interpreted in a short abstract.

Zeolite (916)

Maximum loss in weight over H_2SO_4 of various concentrations at 298.1°K. The pressure of this hydrate changes continuously with the temperature, the residue remaining clear. The pressure is equal to that of a sulfuric acid solution, for which the compound does not change in weight.

Chabasite (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.06	60	0.00580	0.53
20	0.02579	0.12	70	0.00230	0.90
30	0.02320	0.20	80	0.00074	1.46
40	0.01769	0.26	90	0.0003	2.12
50	0.01161	0.30	97	0.00	2.22

Desmine (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.04	60	0.00580	0.32
20	0.02579	0.07	70	0.00230	0.46
30	0.02320	0.11	80	0.00074	0.69
40	0.01769	0.15	90	0.0003	1.47
50	0.01161	0.22	97	0.00	1.80

Heulandite (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.02	60	0.00580	0.27
20	0.02579	0.04	70	0.00230	0.39
30	0.02320	0.08	80	0.00074	0.53
40	0.01769	0.12	90	0.0003	1.26
50	0.01161	0.17	97	0.00	1.53

Potassium Chabasite (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.08	60	0.00580	1.16
20	0.02579	0.14	70	0.00230	1.56
30	0.02320	0.27	80	0.00074	2.23
40	0.01769	0.38	90	0.0003	3.07
50	0.01161	0.72	97	0.00	3.14

Potassium Desmine (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.04	60	0.00580	0.66
20	0.02579	0.11	70	0.00230	0.89
30	0.02320	0.18	80	0.00074	1.16
40	0.01769	0.26	90	0.0003	2.14
50	0.01161	0.44	97	0.00	2.24

Potassium Heulandite (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.00	60	0.00580	0.51
20	0.02579	0.07	70	0.00230	0.72
30	0.02320	0.14	80	0.00074	1.13
40	0.01769	0.20	90	0.0003	2.08
50	0.01161	0.36	97	0.00	2.18

Ammonium Desmine (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.04	60	0.00580	0.81
20	0.02579	0.14	70	0.00230	1.26
30	0.02320	0.21	80	0.00074	1.88
40	0.01769	0.34	90	0.0003	2.34
50	0.01161	0.52	97	0.000	2.46

Calcium Chabasite (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.07	60	0.00580	0.54
20	0.02579	0.13	70	0.00230	0.93
30	0.02320	0.22	80	0.00074	1.49
40	0.01769	0.26	90	0.0003	2.15
50	0.01161	0.31	97	0.00	2.26

Calcium Heulandite (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.02	60	0.00580	0.28
20	0.02579	0.04	70	0.00230	0.41
30	0.02320	0.09	80	0.00074	0.56
40	0.01769	0.13	90	0.0003	1.29
50	0.01161	0.18	97	0.00	1.57

Calcium Desmine (916)

% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss	% H_2SO_4	$P_{\text{H}_2\text{SO}_4}$	H_2O , Mole loss
10	0.02839	0.04	60	0.00580	0.34
20	0.02579	0.07	70	0.00230	0.49
30	0.02320	0.11	80	0.00074	0.73
40	0.01769	0.16	90	0.0003	1.50
50	0.01161	0.24	97	0.00	1.73

For the following zeolites studied by Tammann (1422), the first column (1) gives the pressure of the H_2SO_4 solution, over which the mineral was kept; the second column (2) gives the maximum loss of water in wt. %; the third column (3) gives how much wt. % of water would not be absorbed again for the rehydration of the dehydrated mineral on standing over the said sulfuric acid solution.

(1)	(2)	(3)	(1)	(2)	(3)
Gmelinite, $\text{CaNa}_2\text{Al}_2\text{Si}_4\text{O}_{12} \cdot 6\text{H}_2\text{O}$ (1422)					
0.02068	0.05	0.05	0.00386	1.40	1.41
0.01914	0.08		0.00162	2.48	3.11
0.01642	0.18		0.00051	4.19	4.58
0.01199	0.42		0.00014	4.58	
0.00796	0.75				

DEHYDRATION OF MINERALS.—(Continued)

(1)	(2)	(3)	(1)	(2)	(3)
Phacolite, $\text{CaNa}_2\text{Al}_2\text{Si}_4\text{O}_{12}\cdot 6\text{H}_2\text{O}$ (1422)					
0.02068	0.05	0.05	0.00386	1.81	1.76
0.01914	0.16		0.00162	2.90	
0.01642	0.31		0.00051	3.82	4.56
0.01199	0.60		0.00014	4.47	
0.00796	1.06				
Chabasite, $\text{CaNa}_2\text{Al}_2\text{Si}_4\text{O}_{12}\cdot 6\text{H}_2\text{O}$ (1422)					
0.01914	0.11		0.00162	1.69	
0.01642	0.14		0.00014	3.14	
0.01199	0.37				
Leonhardite, $\text{CaAl}_2\text{Si}_4\text{O}_{12}\cdot 4\text{H}_2\text{O}$ (1422)					
0.01914	0.06		0.00051	3.40	
0.01199	0.70				
Laumontite, $\text{CaAl}_2\text{Si}_4\text{O}_{12}\cdot 4\text{H}_2\text{O}$ (1422)					
0.01914	0.05		0.00051	0.58	
Phillipsite, $(\text{CaK}_2)\text{Al}_2\text{Si}_5\text{O}_{14}\cdot 5\text{H}_2\text{O}$ (1422)					
0.01914	0.18		0.00386	0.40	
0.01642	0.22		0.00051	1.41	
0.01199	0.24				
Gismondite (1422)					
0.01914	0.02	0.16	0.00386	1.48	
0.01642	0.19		0.00162	2.51	
0.01199	0.25	0.29	0.00051	3.42	
0.00796	0.94		0.00014	3.73	
Okenite, $\text{CaO}\cdot 2\text{SiO}_2\cdot 2\text{H}_2\text{O}$ (1422)					
0.02068	0.06	0.27	0.00386	2.10	
0.01914	0.84		0.00162	2.66	
0.01642	1.02	1.25	0.00051	3.21	
0.01199	1.29	1.49	0.00014	3.56	
0.00796	1.67				
Natrolite, $\text{Na}_2\text{Al}_2\text{Si}_3\text{O}_{10}\cdot 2\text{H}_2\text{O}$ (1422)					
0.01914	0.21		0.01199	0.39	
0.01642	0.25		0.00051	0.79	

(1)	(2)	(3)	(1)	(2)	(3)
Scolecite, $\text{CaAl}_2\text{Si}_3\text{O}_{12}\cdot 3\text{H}_2\text{O}$ (1422)					
0.02068	0.000	0.000	0.00796	0.029	0.029
0.01914	0.004		0.00386	0.042	
0.01642	0.013		0.00162	0.079	
0.01199	0.017		0.00014	0.105	
Pyrophyllite, $\text{Al}_2\text{Si}_4\text{O}_{11}\cdot \text{H}_2\text{O}$ (1422)					
0.02068		0.000	0.00796	0.050	
0.01914	0.004		0.00386	0.059	
0.01642	0.013		0.00014	0.060	
0.01199	0.017				
Pitchstone (1422)					
Brown form					
0.02068	0.005		0.00386	0.42	
0.01914	0.005		0.00162	0.60	
0.01642	0.04		0.00051	0.84	
0.01199	0.08		0.00014	0.92	
0.00796	0.17				
Green form					
0.01642	0.04		0.00162	0.75	
0.01199	0.08		0.00051	0.95	
0.00796	0.31		0.00014	1.06	
0.00386	0.57				
Black form					
0.01914	0.01		0.00386	0.04	
0.01642	0.02		0.00162	0.05	
0.01199	0.02		0.00051	0.06	
0.00796	0.04				
Semiopal (1422)					
0.01914	2.96	8.28	0.00386	11.60	
0.01642	3.90	10.80	0.00162	12.09	
0.01199	9.95		0.00014	13.30	
0.00796	10.75	12.18			
Hyalite (1422)					
0.01914		0.00	0.00386	0.05	
0.01642	0.01		0.00162	0.09	
0.01199	0.02		0.00051	0.10	
0.00796	0.03		0.00014	0.12	

LITERATURE; v. p. 347

SOLUBILITY OF SLIGHTLY SOLUBLE SALTS IN AQUEOUS SOLUTIONS OF ELECTROLYTES

MERLE RANDALL AND WILLIAM V. VIETTI

The Standard arrangement (Vol. III, p. viii) is used throughout this section. Under each A-component, printed in large type, are listed the B-components in the standard order. The A-component is the slightly soluble salt; the B-component is a solute in the aqueous solution.

L'arrangement type (Vol. III, p. viii) est utilisé dans toute cette section. Sous chaque constituant A, imprimé en grands caractères, se trouvent les constituants B disposés en liste suivant l'ordre type. Le constituant A est le sel peu soluble; le constituant B est un corps dissous dans la solution aqueuse.

In diesem Abschnitt ist die Standardanordnung (Bd. III, S. viii) durchweg verwendet. Unter jeder A-Komponente, die in grossen Buchstaben gedruckt ist, folgen die B-Komponenten in Standardanordnung. Die A-Komponente ist der wenig lösliche Salz; die B-Komponente ist ein Körper in der wässrige Lösung.

In tutto questo capitolo si fa uso dell'ordinamento standard (Vol. III, p. viii). Sotto ogni componente A stampato in lettere grosse, sono elencati i componenti B con l'ordinamento standard. Il componente A è il sale poco solubile; il componente B è un soluto nella soluzione acquosa.

SYMBOLS AND ABBREVIATIONS

c_B Concentration of B-component in moles/liter.
 c_{\pm} Geometric mean of concentration of ions.

SYMBOLES ET ABRÉVIATIONS

c_B Concentration du constituant B en mol. gr./litre.
 c_{\pm} Moyenne géométrique de la concentration des ions.

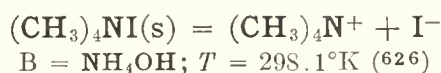
SYMBOLE UND ABKÜRZUNGEN

c_B Konzentration der B-Komponente in Mol. Liter.
 c_{\pm} Geometrisches Mittel der Ionenkonzentrationen.

ABBREVIAZIONI E SIMBOLI

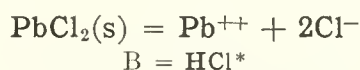
c_B Concentrazione del componente B in moli/litro.
 c_{\pm} Media geometrica della concentrazione degli ioni.

<i>M</i> Molal.	<i>M</i> Moléculaire.	<i>M</i> Molar.	<i>M</i> Molare.
<i>m_B</i> Moles of B-component/ 1000 g H ₂ O <i>in vacuo</i> .	<i>m_B</i> Mol. gr. du constituant B/1000 g H ₂ O dans le vide.	<i>m_B</i> Gramm Mol der B-Kom- ponente/1000 g H ₂ O <i>in vacuo</i> .	<i>m_B</i> Moli del componente B/ 1000 g di H ₂ O nel vuoto.
$\left. \begin{matrix} m_{\pm} \\ m_{\pm}^{\circ} \end{matrix} \right\}$ See p. 227.	$\left. \begin{matrix} m_{\pm} \\ m_{\pm}^{\circ} \end{matrix} \right\}$ Voir p. 227.	$\left. \begin{matrix} m_{\pm} \\ m_{\pm}^{\circ} \end{matrix} \right\}$ Siehe S. 230.	$\left. \begin{matrix} m_{\pm} \\ m_{\pm}^{\circ} \end{matrix} \right\}$ Vedi p. 230.
<i>N</i> Normal	<i>N</i> Normal.	<i>N</i> Normal.	<i>N</i> Normale.
<i>s_A</i> Solubility of A-component in moles/liter.	<i>s_A</i> Solubilité du constituant A en mol. gr./litre.	<i>s_A</i> Löslichkeit der A-Kom- ponente in Gramm Mol/ Liter.	<i>s_A</i> Solubilità del componente A in moli/litro.
<i>S_A</i> Solubility of A-component in moles/1000 g H ₂ O <i>in vacuo</i> .	<i>S_A</i> Solubilité du constituant A en mol. gr./1000 g H ₂ O dans le vide.	<i>S_A</i> Löslichkeit der A-Kom- ponente in Gramm Mol/ 1000 g H ₂ O <i>in vacuo</i> .	<i>S_A</i> Solubilità del componente A in moli/1000 g di H ₂ O nel vuoto.
γ Activity coefficient (see p. 227).	γ Coefficient d'activité (voir p. 227).	γ Aktivitätskoeffiziente (siehe S. 230).	γ Coefficiente di attività (vedi p. 230).
μ Ionic strength.	μ Force ionique.	μ Ionenstärke.	μ Forza ionica.
μ_c Ionic strength (for con- centrations). For other abbreviations, see p. 225.	μ_c Force ionique (pour con- centrations). Pour d'autres abrégés, voir p. 225.	μ_c Ionenstärke (für Konzen- trationen). Für andere Abkürzungen, siehe S. 228.	μ_c Forza ionica (per concen- trazioni). Per altre abbreviazioni, vedi p. 228.

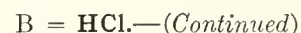


<i>c_B</i>	<i>s_A</i>	<i>c_B</i>	<i>s_A</i>
0.000	0.26248	0.5224	0.26158
.0494	.26223	1.0149	.26062
.1001	.26200	2.1099	.25877
.2102	.26180		
<i>B</i> = KOH; <i>T</i> = 298.1°K (625,* 626)			
0.000	0.26228	0.112	0.25810
.057	.25999	.251	.25073

* For *c_B* = 0.000 to 8.2962, v. (625).



<i>c_B</i>	<i>s_A</i>	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
<i>T</i> = 273.1°K (375)			
0.0	0.02104	1.4766	0.252
.01371	.01624	1.4868	.250
.02743	.01299	1.4771	.2572
.05485	.00794	1.4670	.293
.08228	.00577	1.4314	.361
.1646	.00505	1.2707	.411
.2743	.00433	1.1534	.538
2.743	.00433	0.4947	1.657
5.485	.01877	0.0808	2.354
6.857	.0379	-0.0868	2.639
8.228	.06315	-0.2147	2.900
10.471	.1443	-0.4374	3.375
<i>T</i> = 291.1°K (1147)			
0.0	0.03358	1.2732	0.3170
.0301	.03346	1.2730	.318
.0002	.03344	1.2727	.318
.0005	.03326	1.2740	.317
.00102	.03310	1.2746	.317
.0102	.03019	1.2681	.320
<i>T</i> = 298.1°K (1076)			
0.0	0.03885	1.2093	0.341
.05	.02393	1.2133	.349
.10	.01621	1.1821	.385
.20	.00964	1.1113	.477



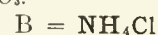
<i>c_B</i>	<i>s_A</i>	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
<i>T</i> = 298.3°K (373.5)			
0.0	0.0388	1.2105	0.341
.0009	.03866	1.2066	.342
.0022	.03820	1.2066	.342
.003	.03794	1.2080	.340
.0045	.03735	1.2078	.341
.0091	.03580	1.2108	.341
.0114	.03499	1.2117	.341
.0151	.03375	1.2126	.341
.0226	.03146	1.2127	.342
.0302	.02932	1.2126	.344
.0452	.02546	1.2124	.348
.0910	.01712	1.1900	.364
.1850	.01012	1.1234	.464
.3714	.00635	1.0095	.617
.5142	.00537	0.9433	.728
.7386	.00473	.8591	.868
1.026	.00441	.7753	1.020
1.538	.00461	.6524	1.245
2.051	.00518	.5525	1.437
2.564	.00625	.3991	1.607
3.085	.00778	.3754	1.763
3.718	.00816	.3146	1.934
5.00	.01938	.2871	2.249
7.50	.06586	.0943	2.774
10.0	.14135	-0.0582	3.229
12.05	.1643	-0.0989	3.541

* For values at 290.9°K, v. (73); at 273.1, 293.1, 313.1, 328.1, 359.1°K, v. (341).



<i>c_B</i>	<i>s_A</i>	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.001	0.03387	1.2097	0.343
.01	.03971	1.2004	.359
.051	.04291	.1666	.424
.01*	.04336	.1622	.424

* 0.01*N* HNO₃ + 0.04*N* KNO₃.



<i>m_B</i>	<i>S_A</i>	<i>m_B</i>	<i>S_A</i>
<i>T</i> = 290.1°K (326)			
0.0	0.323	0.8187	0.00263
.1817	.00762	.8432*	.00301
.4605	.00516		

* Complex in solid phase.

B = NH₄Cl.—(Continued)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 295.1^\circ\text{K}$ (193)			
0.0	0.03745	1.2250	0.334
.1	.01625	1.1815	.385
.2	.0097	1.1102	.479
.3	.00765	1.0397	.569
.4	.0069	0.9758	.648
.5	.0065	.9222	.720
.52	.00635	.9148	.734

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 298.3^\circ\text{K}$ (373.5)			
0.0	0.03880	1.2105	0.341
.25	.00947	1.0548	.527
.50	.00711	0.9086	.722
1.00	.00435	.7630	1.005

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 333.1^\circ\text{K}$ (326)			
0.0	0.06404	0.9186	0.438
.09502	.03995	.9709	.463
.2886	.02472	.8497	.603
.4704	.02158	.7488	.732
.7529	.01887	.6428	.899
.8412	.02046	.5994	.950
.8763	.02204	.5763	.971
$T = 373.1^\circ\text{K}$ (326)			
0.0	0.11503	0.7386	0.587
.2535	.07440	.6390	.690
1.103	.06780	.3270	1.142
1.219	.06866	.2992	1.195
1.799	.07147	.1894	1.424

B = C₂H₄O₂, Acetic acid; $T = 298.1^\circ\text{K}$ (626)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.03877	1.2172	0.341
.050	.03891	1.2093	
.100	.03909	1.2073	
.150	.03880	1.2105	
.200	.03852	1.2136	
.465	.03696	1.2316	
.929	.03452	1.2612	
1.845	.02843	1.3455	
3.680	.01894	1.5218	

B = C₂H₆O, Ethyl alcohol; $T = 298.1^\circ\text{K}$ (758)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0388	1.2105	0.341
.0125	.0367	1.2347	
.025	.0338	1.2704	
.5	.0330	1.2989	
1.0	.0298	1.3251	
2.0	.0257	1.3893	
4.0	.0172	1.5638	

B = C₆H₁₄O₆, Mannitol; $T = 298.1^\circ\text{K}$ (758)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.01563	0.0377	1.2230	
.03125	.0385	1.2138	
.0625	.0384	1.2497	
.125	.0394	1.2039	
.25	.0403	1.1939	
.5	.0408	1.1887	

B = Pb(NO₃)₂

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (570)			
0.0	0.03903	1.2079	0.342
.01005	.03855	1.1798	.382
.02516	.03851	1.1410	.437
.0513	.03922	1.0847	.522
$T = 298.1^\circ\text{K}$ (24)			
0.1000	0.04204	0.9994	0.653
.250	.05127	.8331	.950

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (570)			
0.0	0.03888	1.2099	0.341
.01001	.03838	1.1817	.381
.02503	.03832	1.1465	.436
.04983	.03899	1.0892	.517
.10*	.0416	1.0029	.652

* From (1076).

B = ZnCl₂; $T = 298.1^\circ\text{K}$ (1076)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.0110	1.0886	1.04

B = CdCl₂; $T = 298.1^\circ\text{K}$ (1076)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.025	0.03005	1.1462	0.412
.05	.02405	1.0926	.472
.10	.01775	1.0023	.594

B = HgCl₂; $T = 293.1^\circ\text{K}$ (441)

c_B	s_A	c_B	s_A
0.0	0.03492	0.03683	.04413
.004604	.03569	.05*	.0496
.009208	.03665	.07367	.05348
.01842	.03886	.1474	.06822

* From (1076).

B = MnCl₂; $T = 298.1^\circ\text{K}$ (1076)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.025	0.02505	1.2001	0.387
.05	.01895	1.1478	.454
.10	.01085	1.0910	.577

B = MgCl₂; $T = 298.1^\circ\text{K}$ (1076)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.025	0.02515	1.1990	0.730
.05	.0175	1.1621	.766

B = CaCl₂; $T = 298.1^\circ\text{K}$ (611)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.03895	1.2088	0.342
.05*	.02515	1.1990	.388
.10*	.01775	1.1623	.450
.20	.01095	1.0894	.580
.26	.00696	0.9008	.894
.475	.00563	.7612	1.200
.955	.00771	.5114	1.699
1.515	.01268	.3089	2.140
2.06	.2057	.1495	2.499

* From (1076).

B = CaBr₂; $T = 298.1^\circ\text{K}$ Solid phase contains PbBr₂(?) (611)B = SrCl₂; $T = 298.1^\circ\text{K}$ (611)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.255	0.00678	0.9103	0.880
.51	.00640	.7219	1.245
.69	.00824	.6310	1.445
1.33	.01418	.3298	2.02
1.545	.01578	.2711	2.16
2.065	.02698	.1753	2.50

PbCl₂—(Continued)B = SrBr₂; $T = 298.1^\circ\text{K}$ Solid phase contains PbBr₂(?) (611)

B = BaCl ₂ ; $T = 298.1^\circ\text{K}$ (611)			
c_B	S_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.16	0.00699	1.0421	0.708
.32	.00553	0.8792	.988
.69	.01089	.5588	1.450
1.04	.02388	.3253	1.790

B = BaBr₂; $T = 298.1^\circ\text{K}$ Solid phase contains PbBr₂(?) (611)

B = LiCl; $T = 323.1^\circ\text{K}$ (326)			
m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.4934	0.01649	0.7801	0.737
1.191	.01332	.5685	1.109
1.265	.01411	.5209	1.142
2.515	.01967	.2974	1.630
4.571	.03605	.0365	2.160
7.871	.1141	−0.2914	2.865
11.23	.2851	−0.5329	3.47
14.24	.4283	−0.6630	3.94
15.49	.4820	−0.7051	4.11
17.54	.5190	−0.7511	4.37
21.27	.5357	−0.7760	4.78
23.06	.4961	−0.8193	4.95

B = NaCl; $T = 286.1^\circ\text{K}$ (326)

m_B	S_A	m_B	S_A
0.0	0.02970	3.383	0.01337
.173	.00654	5.319	.05240
.903	.00344	6.221	.09396
2.65	.00794		

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (611)			
0.51	0.00648	0.9172	0.732
1.02	.00631	.7240	1.020
2.05	.00961	.4619	1.443
3.03	.01279	.3076	1.75
4.10	.04377	.0983	2.06

 $T = 323.1^\circ\text{K}$ (326)

0.2851	0.02111	0.8819	0.590
.7626	.01454	.6801	.898
1.428	.02328	.4359	1.220
2.83	.05309	.1132	1.725
3.463	.07005	.0138	1.915
4.121	.1165	−0.1134	2.115
4.856	.2069	−0.2531	2.34
5.173	.2599	−0.3085	2.44

 $T = 373.1^\circ\text{K}$ (326)

0.3565	0.06154	0.4823	0.736
.3638	.05974	.4843	.737
.7429	.05714	.4549	.956
.915	.05884	.3999	1.045
1.253	.06548	.3000	1.205
2.66	.1083	−0.0156	1.728
4.429	.2356	−0.2515	2.26
6.1307	.4830	−0.4293	2.75
6.346	.5223	−0.4858	2.81
6.704	.5855	−0.5207	2.91
7.181	.6900	−0.5685	3.04
7.27	.6928	−0.5725	3.06

B = NaBr; $T = 298.1^\circ\text{K}$ Solid phase contains PbBr₂(?) (611)B = KCl; $T = 287.1^\circ\text{K}$ (326)

m_B	S_A	m_B	S_A
0.0	0.03301	0.4769	0.00449
.1866	.0066	.5347*	.00567
.3358	.00517		

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 293.1^\circ\text{K}$ (194)			
0.199	0.00967	1.1122	0.477
.306	.00744	1.0386	.573
.387	.00683	0.9873	.638
.475	.00648	.9373	.702
.497	.00652	.9235	.718
.502	.00643	.9228	.723
.523	.00644	.9110	.730
.545*	.00643	.8996	.750

* Solid phase contains 2PbCl₂.KCl.

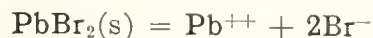
c_B	S_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (1076)			
0.05	0.0241	1.2113	0.350
.10	.01705	1.1711	.389
.20	.1095	1.0894	.486
$T = 298.3^\circ\text{K}$ (373.5)			
0.0	0.0388	1.2105	0.341
.001	.03832	1.2128	.340
.0025	.03785	1.2151	.340
.0049	.03702	1.2123	.340
.0099	.03528	1.2138	.339
.02	.03216	1.2136	.341
.0599	.02262	1.2111	.357
.09991	.01690	1.1647	.387
.5006	.00740	0.9022	.610
.7018	.00738	.8088	.850
.9991	.00490	.7674	1.005
1.5018	.00483	.6524	1.23
2.0024	.00556	.5490	1.42
3.0036	.00974	.3502	1.74

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (326)			
0.1918	0.02840	0.9186	0.526
.3262	.02306	.8318	.628
.4860	.01880	.7626	.736
.6832	.02173	.6468	.865
.8476	.02237	.5831	.956
.8982	.02245	.5665	.982
.9213	.02248	.5593	.994
.9321	.02329	.5505	1.001
.9425	.02136	.5611	1.003

 $T = 373.1^\circ\text{K}$ (326)

0.1289	0.0838	0.7098	0.617
.143	.0844	.6942	.630
.431	.0656	.5600	.792
.5575	.06869	.4925	.874
.7234	.0667	.4395	.961
.8593	.0717	.3723	1.035
1.044	.0738	.3258	1.120
1.207	.0804	.2737	1.203
1.429	.08624	.2178	1.300
1.617	.1045	.1519	1.390
1.695	.10725	.1353	1.425

B = KBr; $T = 298.1^\circ\text{K}$ Solid phase contains PbBr₂(?) (611)B = KNO₃; $T = 298.3^\circ\text{K}$ (373.5); see value in B = HNO₃



$$\text{B} = \text{HBr}; T = 283.1^\circ\text{K}$$

Soln. contained $8.9m_{\text{B}}$ and $1.5S_{\text{A}}$ (341)

$$\text{B} = \text{HNO}_3; T = 298.1^\circ\text{K} (373.5)$$

c_{B}	S_{A}	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.00	0.02628	1.3797	0.281
.001	.02659	1.3746	.283
.01	.02735	1.3624	.304
.05*	.03025	1.3199	.375
.051	.03004	1.3216	.376

* 0.01N HNO_3 + 0.04N KNO_3 .

$$\text{B} = \text{Pb}(\text{NO}_3)_2; T = 298.1^\circ\text{K} (1192)$$

m_{B}	S_{A}	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.00	0.02680	1.3723	0.283
.0020	.02664	1.3634	.293
.0050	.02644	1.3520	.307
.0100	.02622	1.3340	.330
.0200	.02612	1.3001	.372
.0500	.02663	1.2202	.479
.1000	.02954	1.1169	.624
.1326	.03159	1.0612	.692
.2000	.03544	0.9757	.841
.3134	.04333	.8573	1.035
.5000	.05342	.7332	1.288
.703	.06522	.6279	1.519
.9521	.07754	.5354	1.737
1.6547	.1268	.3138	2.310
1.964*	.1346	-0.2727	2.510

* Solid phase, PbBr_2 and $\text{Pb}(\text{NO}_3)_2$.

$$\text{B} = \text{CdBr}_2; T = 298.1^\circ\text{K} (1192)$$

0.0010	0.02637	1.3674	0.286
.0020	.02591	1.3643	.289
.0050	.02466	1.3539	.298
.0100	.02307	1.3321	.315
.0200	.01999	1.2977	.346
.0500	.01450	1.2059	.440
.1000	.01117	1.0860	.577
.1305	.01038	1.0281	.650
.2000	.00939	0.9280	.793
.3236	.00969	.7890	1.000
.5000	.01072	.6505	1.238
.5607	.01143	.6083	1.310
1.000	.01597	.3939	1.745
1.692	.02445	.1803	2.270
4.182*	.06508	.2170	3.570

* Solid phase, PbBr_2 and $\text{CdBr}_2 \cdot 4\text{H}_2\text{O}$.

$$\text{B} = \text{CaCl}_2; T = 298.1^\circ\text{K}$$

Solid phase probably contained $\text{PbCl}_2(\text{s})$ (611)

$$\text{B} = \text{CaBr}_2; T = 298.1^\circ\text{K} (611)$$

c_{B}	S_{A}	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.00	0.02625	1.3803	0.281
.26	.00667	0.9073	.893
.52	.01205	.6217	1.255
1.04	.0438	.2289	1.803
1.565	.1175	-0.0411	2.246
2.085	.5187	-0.3827	2.795

$$\text{B} = \text{SrCl}_2; T = 298.1^\circ\text{K}$$

Solid phase probably contained $\text{PbCl}_2(\text{s})$ (611)

$$\text{B} = \text{SrBr}_2; T = 298.1^\circ\text{K} (611)$$

c_{B}	S_{A}	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.26	0.00673	0.9060	0.883
.52	.01273	.6134	1.264
1.04	.04367	.2294	1.798
1.56	.1559	-0.0880	2.269
2.08	.5687	-0.4010	2.819

$$\text{B} = \text{BaCl}_2; T = 298.1^\circ\text{K}$$

Solid phase probably contained $\text{PbCl}_2(\text{s})$ (611)

$$\text{B} = \text{BaBr}_2; T = 298.1^\circ\text{K} (611)$$

c_{B}	S_{A}	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.225	0.00607	0.9624	0.832
.455	.01091	.6745	1.182
.91	.04443	.2639	1.692
1.38	.1604	-0.0609	2.150
1.835	.4140	-0.3077	2.597

$$\text{B} = \text{Ba}(\text{NO}_3)_2; T = 298.1^\circ\text{K} (1192)$$

m_{B}	S_{A}	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.002	0.02737	1.3664	0.297
.005	.02808	1.3509	.315
.01	.02883	1.3395	.341
.02	.03034	1.3173	.389
.05000	.03370	1.2717	.501
.09045	.03691	1.2322	.618
.1000	.03780	1.2219	.693
.2000	.04385	1.1574	.855
.2105	.04428	1.1532	.874
.3513	.05008	1.0997	1.097
.4116*	.05337	1.0720	1.222

* Solid phase, $\text{PbBr}_2(\text{s})$ and $\text{Ba}(\text{NO}_3)_2(\text{s})$.

$$\text{B} = \text{NaCl}; T = 298.1^\circ\text{K}$$

Solid phase probably contained $\text{PbCl}_2(\text{s})$ (611)

$$\text{B} = \text{NaBr}; T = 298.1^\circ\text{K} (611)$$

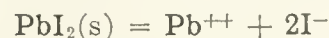
c_{B}	S_{A}	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.73	0.00860	0.7727	0.869
1.47	.02247	.4292	1.240
2.20	.07043	.1375	1.553
2.93	.1958	-0.1115	1.875
3.67	.3936	-0.2977	2.202
4.40	.7337	-0.4675	2.569

$$\text{B} = \text{KCl}; T = 298.1^\circ\text{K}$$

Solid phase probably contained $\text{PbCl}_2(\text{s})$ (611)

$$\text{B} = \text{KBr}; T = 298.1^\circ\text{K} (1192)$$

m_{B}	S_{A}	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.001	0.02645	1.3714	0.283
.002	.02611	1.3718	.283
.0050	.02500	1.3734	.283
.0100	.02345	1.3732	.283
.0200	.02043	1.3737	.285
.0500	.01380	1.3594	.303
.1000	.00859	1.3097	.347
.2000	.00694	1.1661	.470
.3740	.00687	0.9955	.628



$$T = 298.1^\circ\text{K} (862)$$

S_{A}	$\log (1/c_{\pm})$	μ_c
0.00165	2.5818	0.0703

PbI₂—(Continued)
B = HNO₃; T = 298.3°K (373.5)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.00158	2.6006	0.0688
.001	.00165	2.5818	.0771
.01	.00184	2.5345	.1246
.051	.00223	2.4510	.240
.01*	.00223	2.4510	.240

* 0.01N HNO₃ + 0.04N KNO₃.**B = NH₄I**

m _B	S _A	log (1/m _±)	μ ^{1/2}
T = 293.1°K (326)			
0.0	0.001301	2.6850	0.0625
.2532	.0006507	1.4584	.505
.4448	.000694	1.2889	.668
.5207*	.00232	1.0645	.726
T = 333.1°K (326)			
0.0	0.00369	2.2656	0.1052
.4462	.00319	1.0616	.676
.7593	.00360	0.8916	.878
1.0986*	.00729	.6814	1.053

* Solid phase, PbI₂(s) + PbNH₄I₃·2H₂O(s).**B = KI**

T = 286.1°K (326)			
0.0	0.00108	2.766	0.0569
.1361	.0000221	2.1292	.3691
.2626	.0000226	1.8057	.5125
.6024	.0000694	1.5329	.7741
.9813	.0000755	1.3794	.9910
1.1488*	.001291	0.9222	1.0740
T = 333.1°K (326)			
0.0	0.00369	2.2656	0.1052
.17608	.0000434	1.9567	.3195
.6199	.000477	1.2427	.788
1.0199	.0005076	1.0922	1.011
1.2669	.003154	0.7638	1.129
1.394	.003744	.7112	1.185
1.462	.004048	.6860	1.214
1.6072	.007442	.5761	1.276
2.5885	.05748	.1253	1.661
2.7523	.08169	.0528	1.731
2.939	.1036	−0.0036	1.803

* Solid phase, PbI₂(s) + PbKI₃·2H₂O.**Pb(IO₃)₂(s) = Pb⁺⁺ + 2IO₃[−]**log (1/c_±^o) = 4.076**B = Pb(NO₃)₂; T = 298.1°K (573)**

c _B	s _A	log (1/c _±)	μ _c ^{1/2}	log γ _c
0.0	0.0000551	4.0581	0.01286	−0.018
.00005	.0000435	4.0500	.01675	−0.026
.0005	.0000206	4.0186	.03952	−0.057
.005	.00000925	3.9219	.1226	−0.154
.050	.000008	3.6309	.3873	−0.445
.250	.000014	3.2359	.8660	−0.840
1.50	.000075	2.4906	2.121	−1.585

B = KIO₃; T = 298.1°K (573)

0.00005304	0.00003575	4.0855	0.01266	0.009
.0001061	.00002185	4.1032	.01310	.027

B = KNO₃; T = 298.1°K (573)

0.002	0.00005705	4.0431	0.04659	−0.033
.010	.0000667	3.9752	.1010	−0.101
.050	.0001019	3.7912	.2243	−0.285

PbSO₄(s) = Pb⁺⁺ + SO₄[−]
B = HCl; T = 291.1°K (71); cf. (1235)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.000126	3.899	0.0225
.1	.000917	3.037	.3220
.2	.00172	2.764	.4549
.3	.00267	2.573	.5575
.4	.00363	2.439	.6430

B = H₂SO₄; T = 298.1°K (1147); cf. (342)

0.0	0.000126	3.899	0.0225
.00005	.000110	3.877	.0243
.0001	.000101	3.846	.0265
.00025	.000064	3.848	.0317
.0005	.000043	3.816	.0409
.005	.000017	3.535	.1228

B = HNO₃; T = 291.1°K (71); cf. (1235)

0.1	0.000506	3.296	0.3193
.2	.000844	3.072	.4475
.3	.00113	2.947	.5518
.4	.00144	2.841	.6370

B = NH₄C₂H₃O₂, Ammonium acetate; T = 298.1°K (952, 1090.5)

m _B	S _A	m _B	S _A
0.0	0.000135	0.7365	0.01962
.104	.00212	1.580	.06320
.2094	.00459	3.708	.1715
.4285	.01037		

B = NaCl; T = 291.1°K (71)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.1	0.000546	3.263	0.3197
.2	.000904	3.044	.4512
.3	.00128	2.893	.5523
.4	.00163	2.775	.6377

B = NaC₂H₃O₂, Acetate; T = 298.1°K (443)

m _B	S _A	m _B	S _A
0.9098	0.02609	3.926	0.3714
1.8	.09992	4.673	.5224
2.981	.2342	2.5*	.1858

* 291 – 293°K.

B = KC₂H₃O₂, Acetate (443)

Th(C₂O₄)₂·6H₂O(s) = Th⁺⁺⁺⁺ + 2C₂O₄[−] + 6H₂O(l)
B = HCl

m _B *	S _A †	m _B *	S _A †
T = 290.1°K (301)			
0.0	0.0000416	2.30	0.000416
.329	.0000857	3.59	.000686
.878	.0000115	4.44	.000931
.987	.0000149	5.43	.00157
1.26	.000230		
T = 333.1°K (301)			
0.0	0.0000416	4.42	0.00252
1.12	.000245	4.94	.00328
2.30	.000686	5.46	.00414
3.40	.00139	5.92	.00568

* See (301) for B = HCl + H₂C₂O₄. † Per 1000 g solution.**B = H₂SO₄**

c _B	s _A *	c _B	s _A *
T = 298.1°K (592)			
0.5	0.00098	2.5	0.00757
.5	.00114		

B = H₂SO₄.—(Continued)

c _B	s _A [*]	c _B	s _A [*]
<i>T</i> = 298.1°K (1534)			
0.25	0.000975	1.544	0.00572
.50	.001475	1.672	.00679
.725	.001703	2.113	.00938
1.08	.00416		
<i>T</i> = 298.1°K (594); <i>cf.</i> (1324)			
0.0625	0.000264	0.525	0.00158
.125	.000529	.800	.00268
.250	.000983	1.225	.00499

* Per 1000 g solution.

B = H₂C₂O₄, Oxalic acid; *T* = 290.1°K (301); *cf.* (594)

c _B	s _A ^{*†}	c _B	s _A ^{*†}
0.189	0.0000049	1.033	0.000024
.722	.0000171	2.556	.00073
<i>T</i> = 298.1°K (594)			
0.75	s _A = ThO ₂ †	satd.	s _A = ThO ₂ †
	0.0015		0.0030

* See (301) for B = H₂C₂O₄ + HCl at 290.1 and 323.1°K. † Per 1000 g solution.B = (NH₄)₂C₂O₄, Ammonium oxalate

<i>T</i> = 298.1°K (592)			
0.005	0.00004	satd.	0.561
.05	.0083	satd.	.550
.25	.0666		
<i>T</i> = 298.1°K (594)			
0.00033	0.000050	0.00120	0.000208
.00044	.000081	.00130	.000220
.00072	.00012	.00148	.000250
.00109	.000200	.00153	.000260

Th(C₂O₄)₂·6H₂O(amorph.) = Th⁺⁺⁺⁺ + 2C₂O₄⁻⁻ + 6H₂O
(1)B = HCl; *T* = 298.1°K (1324)

c _B	s _A	c _B	s _A
0.25	0.0000235	1.00	0.0001084
.50	.0000438		

B = H₂SO₄; *T* = 298.1°K (1324)

0.125	0.0001109	0.5	0.0005270
.25	.0002401		

TiCl(s) = Ti⁺ + Cl⁻log (1/*m*_±) = 1.8630 ± 0.002; log 1/*c*_±[±] = -1.8630 ± 0.002 (1192)

B = HCl

c _B	s _A	log (1/ <i>c</i> _±)	μ _c [‡]
<i>T</i> = 298.1°K (1075, 1076) corrected by (175)			
0.0	0.01607	1.7940	0.1265
.025	.008654	1.7677	.1834
.0283 (1075)	.00834	1.7575	.191
.05	.00583	1.7437	.2364
.0560 (1075)	.00564	1.7294	.248
.01	.00383	1.7002	.3215
.1468 (1075)	.00315	1.6629	.387
.2	.002534	1.6452	.450
1.00 (1075)	.00200	1.3492	1.001

B = HNO₃; *T* = 298.1°K* (629, 630)

m _B	S _A	log (1/ <i>m</i> _±)	μ [‡]
0.0	0.01657	1.7807	0.1285
.5169	.02571	1.6899	.736
1.0804	.03092	1.5098	1.055
2.3700	.03941	1.4044	1.550
5.4512	.05625	1.2499	2.350

* The temperature is probably higher than 298.1°K.

B = NH₄Cl; *T* = 298.1°K (1075, 1076) corrected by (175)

c _B	s _A	log (1/ <i>c</i> _±)	μ _c [‡]
0.025	0.00875	1.7647	0.1835
.05	.00591	1.7404	.236
.2	.00270	1.6301	.450

B = NH₄NO₃; *T* = 298.1°K (468)

0.0	0.01606	1.7943	0.1265
.5	.02587	1.5872	.7254
1	.03121	1.5057	1.015
2	.03966	1.4016	1.428

B = C₂H₄O₂, Acetic acid; *T* = 298.1°K (625); *cf.* (626)

m _B	d ₄ ²⁵	S _A	log (1/ <i>m</i> _±)
0.0		0.01634	1.7828
.5310	0.9986	.01639	1.7854
1.080	1.0014	.01595	1.7973
2.272	1.0085	.01495	1.8254
5.43	1.0295	.01281	1.8925
14.53	1.0521	.00960	2.0177
31.00	1.0570	.00708	2.1500
70.00	1.0614	.00605	2.2183
150.00	1.0638	.00467	2.3307

c _B	s _A	log (1/ <i>c</i> _±)	μ _c [‡]
<i>T</i> = 298.1°K (626)			
0.0	0.016085	1.7934	
.0501	.016027	1.7951	
.0958	.016006	1.7956	
.263	.015662	1.8052	
.524	.015258	1.8164	

B = TiClO₃; *T* = 298.1°K (1075) corrected by (175)

0.025	0.00893	1.7591	0.184
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B = TiBrO₃; *T* = 312.85°K (1077)

c _B	s _A	log (1/ <i>c</i> _±)	μ _c [‡]
0.0	0.02523	1.5981	0.1588
0.01567	0.01952	1.5816	0.1876

B = Ti₂SO₄; *T* = 298.1°K (231)

m _B	S _A	log (1/ <i>m</i> _±)	μ [‡]
0.0	0.01612	1.7926	0.1268
.02511	.00683	1.7132	.2865
.05039	.00467	1.6537	.394

c _B	s _A	log (1/ <i>c</i> _±)	μ _c [‡]
<i>T</i> = 298.1°K (175)			
0.0	0.01615	1.7918	0.1271
.01004	.01039	1.7497	.2012
.01415*	.00883	1.7415	.1515
.02511	.006804	1.7056	.2865
.0280*	.00624	1.7054	.185
.05029	.004708	1.6524	.394

m _B	S _A	log (1/ <i>m</i> _±)	μ [‡]
<i>T</i> = 323.1°K (231)			
0.0	0.03341	1.4761	0.1827
.02542	.02095	1.4114	.3112
.05076	.01591	1.3643	.4100

* From (1075) corrected by (175).

B = TiNO₃; *T* = 298.1°K (231)

0.0	0.01612	1.7926	0.1268
.05035	.00619	1.7284	.237
.10075	.00416	1.6851	.324
.20284	.00304	1.6017	.453

TiCl₃—(Continued)
B = TiNO₃—(Continued)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (1075) corrected by (175)			
0.0	0.01607	1.7940	0.1266
.0283	.00828	1.7584	.1905
.0560	.00570	1.7269	.248
.1468	.00331	1.6519	.387
m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (1076) corrected by (175)			
0.0	0.01607	1.7940	0.1265
.025	.0088	1.7633	.1838
.05	.00624	1.7274	.2371
.1	.00422	1.6783	.3228
$T = 323.1^\circ\text{K}$ (231)			
0.0	0.03341	1.4761	0.1827
.10167	.01404	1.3947	.340
.20481	.01034	1.3264	.463
B = TiCNS			
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (1075)			
0.0	0.01607	1.7940	0.1265
.0107	.0119	1.7844	.1503
$T = 312.84^\circ\text{K}$ (1077)			
0.02149	0.01807	1.7430	0.1989
B = ZnCl₂; $T = 298.1^\circ\text{K}$ (1076) corrected by (175)			
0.0	0.01607	1.7940	0.1265
.0125	.00896	1.7584	.215
.025	.00625	1.7270	.285
.05	.00411	1.6844	.392
.1	.00280	1.6229	.550
B = ZnSO₄			
m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 273.1^\circ\text{K}$ (231)			
0.0	0.006701	2.1739	0.0819
.04997	.008746	2.0582	.457
.1	.009786	2.0094	.639
.2998	.01213	1.9161	1.100
.5986	.01421	1.8474	1.552
$T = 298.1^\circ\text{K}$ (231)			
0.0	0.01612	1.7926	0.1268
.05013	.02065	1.6851	.470
.10021	.02284	1.6413	.650
.30045	.02773	1.5571	1.108
.60062	.03209	1.4936	1.559
$T = 323.1^\circ\text{K}$ (231)			
0.0	0.04081	1.4761	0.1827
.05066	.04520	1.3892	.4935
.10142	.04520	1.3448	.6712
.3047	.05432	1.2650	1.1285
.6093	.06265	1.2031	1.5810
B = CdCl₂; $T = 298.1^\circ\text{K}$ (1076) corrected by (175)			
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.1940	0.1265
.0125	.01037	1.7178	.218
.025	.00778	1.6736	.287
.05	.00576	1.6076	.394
.1	.00426	1.5302	.551
B = CdSO₄; $T = 298.1^\circ\text{K}$ (1075) corrected by (175)			
0.015	0.0206	1.5665	0.1887
.03935	.0254	1.3912	.2545
.0787	.0309	1.2343	.3311

B = CuCl₂; $T = 298.1^\circ\text{K}$ (1076) corrected by (175)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.7940	0.1268
.0125	.00903	1.7562	.215
.025	.00612	1.7321	.285
.05	.00421	1.6789	.392
.1	.00290	1.6144	.550

B = MnCl₂; $T = 298.1^\circ\text{K}$ (1076) corrected by (175)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.7940	0.1268
.0125	.00895	1.7587	.215
.025	.00615	1.7309	.285
.05	.00411	1.6894	.392
.1	.00285	1.6189	.550

B = FeCl₂; $T = 298.1^\circ\text{K}$ (569)
 (569) states same solubility as in BaCl₂ (175)

B = La₂(SO₄)₃

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 273.1^\circ\text{K}$ (231)			
0.0	0.00670	2.1739	0.0819
.01001	.00747	2.1267	.3965
.01502	.00806	2.0937	.482
.02005	.00830	2.0809	.555
.02507	.00847	2.0721	.620
$T = 298.1^\circ\text{K}$ (231)			
0.0	0.01612	1.7926	0.1268
.01004	.01809	1.7433	.410
.01508	.01845	1.7352	.484
.02012	.01925	1.7176	.566
.02516	.01950	1.7120	.630

B = La(NO₃)₃; $T = 298.1^\circ\text{K}$ (1174)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.01611	1.7929	0.1269
.005215	.01740	1.7594	.2224
.008808	.01778	1.7500	.2657
.02024	.01946	1.7109	.3754
.04180	.02129	1.6718	.5216
.08166	.02433	1.6138	.7171
.1970	.02697	1.5692	1.100

B = MgCl₂; $T = 298.1^\circ\text{K}$ (1076) corrected by (175)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.7940	0.1265
.0125	.00901	1.7559	.147
.025	.00616	1.7297	.176
.05	.00412	1.6882	.233
.10	.00274	1.6268	.320

B = MgSO₄; $T = 298.1^\circ\text{K}$ (1174)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.01611	1.7929	0.1269
.01708	.01920	1.7127	.2958
.03364	.02042	1.6899	.3937
.04384	.02106	1.6765	.4454
.06259	.02214	1.6548	.5220
.1291	.02504	1.6014	.7358
.1994	.02641	1.5782	.9078
.3529	.02878	1.5409	1.2002

B = CaCl₂; $T = 298.1^\circ\text{K}$ (1076) corrected by (175)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.7940	0.1265
.0125	.00893	1.7593	.215
.025	.00622	1.7281	.285
.05	.00416	1.6867	.392
.1	.00283	1.6206	.550

B = BaCl₂; $T = 298.1^\circ\text{K}$ (1076) corrected by (175)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.7940	0.1265
.01415*	.00855	1.7508	.226
.025	.00618	1.7297	.285
.05	.00424	1.6772	.393
.0734*	.00322	1.6580	.472

* (1075).

B = LiNO₃; $T = 298.1^\circ\text{K}$ (468)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01606	1.7943	0.1265
.5	.02542	1.5948	.7249
1	.03035	1.5178	1.015
2	.03785	1.4219	1.427
3	.04438	1.3528	1.744

B = NaCl; $T = 298.1^\circ\text{K}$ (1076) corrected by (175)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.7940	0.1265
.025	.00867	1.7669	.1835
.05	.00590	1.7408	.236
.1	.00394	1.6989	.322
.2	.00270	1.6308	.450

B = NaClO₃; $T = 298.1^\circ\text{K}$ (468)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01606	1.7943	0.1265
.5	.02320	1.6345	.7233
1	.02687	1.5707	1.1425
2	.03060	1.5142	1.425
3	.03303	1.4810	1.7415
4	.03850	1.4145	2.01

B = NaNO₃; $T = 298.1^\circ\text{K}$ (468)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01606	1.7943	0.1265
.5	.02564	1.5910	.725
1	.03054	1.5151	1.014
2	.03851	1.4144	1.428
3	.04544	1.3425	1.745
4	.05128	1.2900	2.013

B = NaC₂H₃O₂, Acetate; $T = 298.1^\circ\text{K}$ (1075) corrected by (175)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.7940	0.1265
.0150	.0163	1.7878	.177
.0300	.0169	1.7721	.216
.0787	.0181	1.7423	.311
.1574	.0192	1.7167	.420

B = KCl; $T = 298.1^\circ\text{K}$ (231)

m_B	s_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.01612	1.7926	0.1265
.05025	.00589	1.7403	.237
.10051	.00389	1.6957	.322
.20190	.00260	1.6372	.451
.50911	.00179	1.5194	.714

 $T = 298.1^\circ\text{K}$ (1075) corrected by (175); cf. (199)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01607	1.7940	0.1265
.025	.00869	1.7667	.1835
.05	.00590	1.7408	.2364
.1	.00396	1.6927	.3224
.2	.00268	1.6325	.4502
.8	.00170	1.4237	.8954

 $T = 323.1^\circ\text{K}$ (231)

m_B	s_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.033412	1.4761	0.1827
.05071	.01861	1.4448	.2633
.10151	.01300	1.4136	.3384
.2036	.00909	1.3568	.4612
.5140	.00623	1.2447	.7211

B = KClO₃; $T = 298.1^\circ\text{K}$ (468)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.5	0.5237	1.6252	0.7237

B = K₂SO₄; $T = 298.1^\circ\text{K}$ (175)

m_B	s_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.01615	1.7918	0.1271
.01006	.01787	1.7479	.2002
.02511	.01953	1.7093	.314
.05028	.02151	1.6674	.415
.1515	.02628	1.5814	.686
.5133	.03512	1.4544	1.255

B = KNO₃

$T = 273.1^\circ\text{K}$ (231)			
0.0	0.006701	2.1739	0.0819
.0501	.007894	2.1027	.2405
.2015	.009623	2.0167	.459
.5094	.01206	1.9191	.721
1.0401	.015310	1.8150	1.025

$T = 298.1^\circ\text{K}$ (231)			
0.0	0.01612	1.7926	0.1268
.05028	.01836	1.7361	.262
.20234	.02176	1.6623	.473
.51228	.02619	1.5819	.733
1.0487	.03178	1.4979	1.040

$T = 298.1^\circ\text{K}$ (175); cf. (199)			
0.0	0.01615	1.7918	0.127
.0201	.01725	1.7632	.193
.0503	.01838	1.7467	.262
.1008	.01977	1.7040	.347
.3080	.02375	1.6243	.575
1.047	.03217	1.4925	1.037

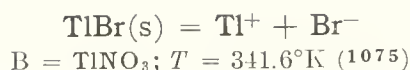
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$ (468)			
0.0	0.01606	1.7943	0.1265
.5	.02566	1.5907	.725
1.0	.03077	1.5119	1.019
2	.03904	1.4085	1.428

$T = 298.1^\circ\text{K}$ (1075) corrected by (175)			
0.015	0.0170	1.7695	0.1789
.03	.0179	1.7471	.2189
.0787	.0192	1.7167	.3129
.1574	.0212	1.6736	.4226

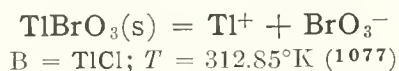
m_B	s_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 323.1^\circ\text{K}$ (231)			
0.0	0.03341	1.4761	0.1827
.05075	.03652	1.4375	.295
.20435	.04226	1.3741	.495
.51797	.04966	1.3040	.753
1.06067	.05859	1.2322	1.052

TiClO₃ (s) = Ti⁺ + ClO₃⁻B = Ti₂SO₄; $T = 293.1^\circ\text{K}$ (1078)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.1340	0.8729	0.3611
.0683	.1058	.5889	.5574

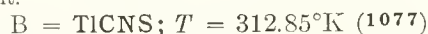


c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00869	2.0609	0.09311
.0163	.00410	2.0387	.1428
.0294	.00289	2.0150	.1797
.0995	.00148	1.9127	.3178



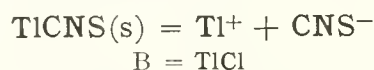
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.02216	1.6544	0.1489
0.01952*	0.01567	1.6292	0.1876

* TlCl(s) present.



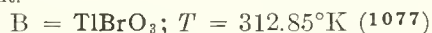
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02210*	0.01496	1.6280	0.1925

* TlCNS (s) present.

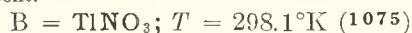


c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 298.1^\circ\text{K} \text{ (1075)}$			
0	0.0149	1.8286	0.1221
0.0119*	.0107	1.8082	.1503
$T = 312.85^\circ\text{K} \text{ (1077)}$			
0.0	0.02773	1.5570	0.1665
.01807*	0.03956	1.5452	.1989

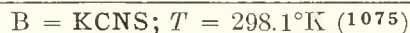
* TlCl(s) present.



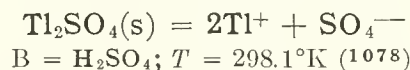
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.01496 _{satd.}	0.03706*	1.5433	0.1925

* TlBrO₃(s) present.

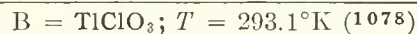
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0149	1.8286	0.1221
.0227	.00852	1.7875	.1767
.0822	.00406	1.7278	.2937



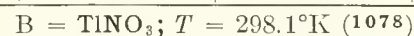
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0227	0.0083	1.7947	0.1761



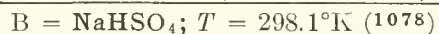
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.1083	0.7646	0.570
.0247	.1172	.7027	.652
.04935	.1249	.6545	.723



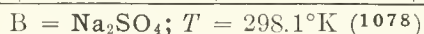
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0964	0.8152	0.538
.1058	.0683	.7988	.558



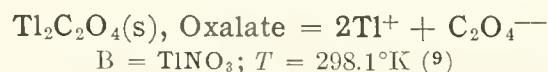
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0996	0.08365	0.7416	0.593



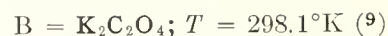
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0505	0.1161	0.6821	0.707



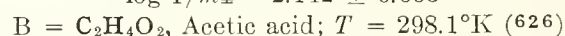
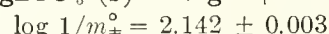
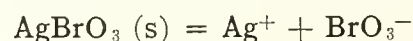
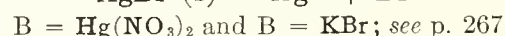
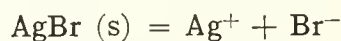
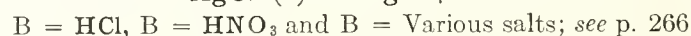
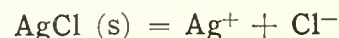
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02485	0.1080	0.7359	0.632



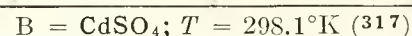
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.03768	1.2232	0.336
.04114	.0264	1.2108	.347
.0799	.0195	1.1865	.372
.1597	.01235	1.1256	.444



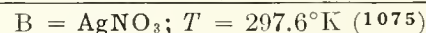
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0498	0.0351	1.1261	0.505
.0996	.03565	1.0541	.637
.2467	.0390	0.9199	.926
.4886	.04506	.7877	1.262
.9785	.05536	.6324	1.763



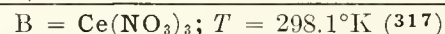
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.008267	2.0827	0.09092
.0498	.008240	2.0840	
.0997	.008219	2.0851	
.1995	.008145	2.0891	
.4988	.007904	2.1022	
.9975	.007639	2.1169	
1.8721	.006861	2.1636	



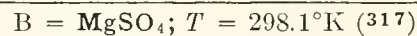
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.008062	2.0937	0.0898
.1	.01041	1.9828	.6406
.5	.01335	1.8745	1.419



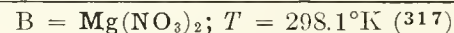
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00810	2.0915	0.0900
.00850	.00510	2.0794	.1167
.0346	.00216	2.0500	.1917



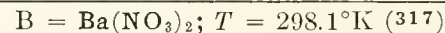
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0125	0.008888	2.0512	0.2835
.025	.009336	2.0298	.3992



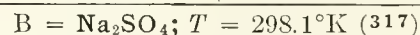
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00892	2.0497	0.2212
.051	.00967	2.0143	.4622
.1	.0103	1.9872	.6406
.1988	.01138	1.9439	.8981



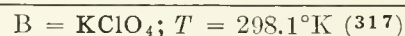
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.025	0.008935	2.0489	0.2897
.05	.009414	2.0263	.3983
.10	.01009	1.9961	.5576



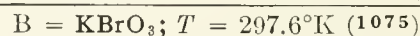
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.025	0.009088	2.0415	0.2900
.05	.009655	2.0153	.3995
.10	.010373	1.9841	.5571



c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.05	0.009965	2.0015	0.400
.10	.01097	1.9597	.5706
1.00	.01862	1.7300	1.737



c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.025	0.008716	2.0596	0.1836
.05	.009190	2.0367	.2433
.10	.009706	2.0129	.3312



c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.00850	0.00519	2.0742	0.117
.0346	.00227	2.0386	.192

B = K₂SO₄; T = 298.1°K (317)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.025	0.00929	2.0159	0.2903
.05	.01002	1.9994	.400
.1	.01109	1.955	.5577

B = KNO₃; T = 298.1°K (317)

0.040	0.00912	2.0400	0.2221
.100	.00992	2.0035	.3303
.200	.01106	1.9562	.4594
.394	.01266	1.8976	.6377

AgI (s) = Ag⁺ + I⁻B = Hg(NO₃)₂ and B = AgNO₃; see p. 268AgIO₃(s) = Ag⁺ + IO₃⁻s_A = 1.89 × 10⁻⁴ (1084)log (1/m_±^o)(298.1) = 3.762 ± 0.003; K_{298.1} = 5.29 × 10⁻⁸B = HNO₃; T = 298.1°K (629, 630)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.000178	3.7496	0.01334
.125	.000304	3.5171	.354
.25	.000379	3.4214	.5004
.5	.000499	3.302	.7075
1.0	.000731	3.136	1.001
2.0	.001174	2.930	1.415
4.0	.002469	2.6075	2.000
8.0	.005608	2.2511	2.829

AgNO₂ (s) = Ag⁺ + NO₂⁻log (1/m_±^o)(298.1) = 1.850 from K_{298.1} = 2.0 × 10⁻⁴ (6) from (5, 892, 1049, 1050)B = AgNO₃

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
T = 298.1°K (313)			
0.0	0.0269	1.5702	0.164
.00258	.0260	1.5644	.169
.00588	.0244	1.5657	.174
.01177	.0224	1.558	.185
.02355	.0192	1.542	.207
.04710	.0164	1.4913	.252
T = 291.1°K (1049)			
0.0	0.02067	1.6846	0.1438
.00258	.01975	1.6777	.1494
.00517	.01900	1.6689	.1555
.01033	.01689	1.6687	.1650
.02067	.01435	1.6494	.1871
.04134	.01168	1.6040	.2303
.08268	.00961	1.5270	.3038

B = KNO₂; T = 298.1°K (313)

0.00258	0.0259	1.5660	0.1688
.00588	.0249	1.5577	.1754
.01177	.0232	1.5454	.187
.02355	.0203	1.5252	.2094
.04710	.0181	1.4640	.2552

AgC₂H₃O₂, Acetate = Ag⁺ + C₂H₃O₂⁻B = C₂H₄O₂, Acetic acid; T = 298.1°K (769)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.06635	1.1782	0.2576
1	.0643	0.5823	
2	.0618	.4474	
2.98	.0598	.3702	
4.19	.0570	.3089	
5.99	.0532	.2464	

B = C₂H₄O₂—(Continued)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
8.01	0.0463	0.2140	
9.96	.0406	.1956	
12.32	.0319	.2022	
13.97	.0257	.2221	
14.96	.0206	.2558	
15.93	.0149	.3127	
17.28	.00653	.4736	

B = Pb(C₂H₃O₂)₂, Acetate; T = 298.1°K (677)

0.0	0.0667	1.1759	0.2583
.01	.06403	1.1346	.3067
.05	.0566	1.0262	.4545
.1	.04995	0.9518	.5916
.5	.04349	.6715	1.242
1.0	.03587	.5711	1.743

B = Cd(C₂H₃O₂)₂, Acetate; T = 298.1°K (677)

0.01	0.06224	1.1454	0.3037
.05	.04852	1.0711	.4455
.1	.04021	1.0075	.583
.5	.02592	0.7876	1.235
1.0	.02363	.6601	1.739

B = AgNO₃

T = 289.1°K (1051)

0.0	0.0603	1.2196	0.2484
.061	.0417	1.1841	.3205
.119	.0341	1.1411	.3913
.230	.0195	1.1564	.4995

T = 292.9°K (26)

0.0	0.0590	1.2291	0.2429
.0533	.0411	1.2056	.3072
.1	.0311	1.1948	.3621

T = 298.1°K (677)

0.01634	0.0595	1.1728	0.2754
.03268	.0540	1.1648	.2944
.06535	.0444	1.1561	.3312
.1307	.0348	1.1199	.4063

B = NaC₂H₃O₂, Acetate; T = 289.1°K (1051)

0.061	0.0392	1.2029	0.3597
.119	.0280	1.1927	.3834
.230	.0208	1.1412	.5010

T = 289.1°K (1049)

0.0	0.0569	1.2448	0.2385
.0569	.03748	1.2256	.3072
.1138	.02787	1.2018	.3764
.2276	.01973	1.1558	.4973

T = 291.7°K (26)

0.0	0.0593	1.2269	0.2435
.0333	.0474	1.2087	.2841
.0667	.0384	1.1970	.3242
.1333	.0282	1.1708	.4018
.2667	.0203	1.1173	.5357
.5000	.0147	1.0605	.7173

T = 298.1°K (677)

0.0240	0.05557	1.1771	0.2821
.2403	.02519	1.0874	.5153
1.201	.01396	0.8853	1.102
2.403	.01239	.7620	1.554

B = KC₂H₃O₂, Acetate; T = 298.1°K (677)

0.0226	0.0575	1.1973	0.2648
.2262	.02653	1.0868	.5027
1.131	.01442	0.8911	1.070
2.262	.01305	.7637	1.510

$\text{AgC}_2\text{H}_2\text{ClO}_2(\text{s})$, Chloroacetate = $\text{Ag}^+ + \text{C}_2\text{H}_2\text{ClO}_2^-$
 $\text{B} = \text{HNO}_3$; $T = 298.1^\circ\text{K}$ (629, 630)

c_B	s_A	d	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0737	1.0095	1.1325	0.2715
.2405	.2546	1.0426	0.5941	.7036
.4738	.4560	1.0791	0.3410	.9642
.9525	.8309	1.1473	0.0904	1.335
1.751	1.543	1.2716	-0.1884	1.815
3.271	2.726	1.4749	-0.4355	2.449
3.918	3.273	1.5673	-0.5149	2.644

$\text{B} = \text{AgNO}_3$; $T = 290.0^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0644	1.1911	0.2538
.0533	.0449	1.1567	.329
.1	.0373	1.1453	.3705

$\text{B} = \text{NaC}_2\text{H}_2\text{ClO}_2$, Chloroacetate; $T = 290.0^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0333	0.0499	1.1909	0.2885
.0667	.0405	1.1812	.3274
.1333	.0299	1.1557	.404
.2667	.0208	1.1112	.5362
.5	.0162	1.0388	.7185

$\text{AgC}_3\text{H}_5\text{O}_2(\text{s})$, Propionate = $\text{Ag}^+ + \text{C}_3\text{H}_5\text{O}_2^-$
 $\text{B} = \text{C}_3\text{H}_6\text{O}_2$, Propionic acid; $T = 298.1^\circ\text{K}$ (769)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0	0.04782	1.3203	0.2187
1	.04539	0.6618	1.022
2	.04237	.5313	1.429
2.97	.04020	.4586	1.735
4.95	.03587	.3738	2.233
6.97	.03057	.3347	2.646
8.56	.02623	.3240	2.929
11.40	.01671	.3597	3.380
13.03	.01148	.4154	3.611

$\text{B} = \text{AgNO}_3$; $T = 292.8^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0462	1.3353	0.2150
.0167	.0393	1.3286	.2366
.0333	.0345	1.3154	.2604
.0667	.0258	1.3064	.3074
.1333	.0191	1.2679	.3904
.2667	.0131	1.2179	.5290
.5000	.0101	1.1440	.7142

$\text{B} = \text{NaC}_3\text{H}_5\text{O}_2$, Propionate; $T = 291.1^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0471	1.3269	0.217
.0133	.0415	1.3653	.2117
.0267	.0379	1.3056	.2542
.0533	.0307	1.2943	.2898
.1	.0222	1.2832	.3496

$\text{AgC}_4\text{H}_7\text{O}_2$, Butyrate = $\text{Ag}^+ + \text{C}_4\text{H}_7\text{O}_2^-$
 $\text{B} = \text{AgNO}_3$; $T = 291.9^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0228	1.6420	0.151
.0667	.0078	1.6179	.273
.1	.0062	1.5907	.3257

$\text{B} = \text{AgC}_2\text{H}_3\text{O}_2$, Acetate; $T = 290.9^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0221	1.6556	0.1486
.0270	.0139	1.6226	.2022
.0506	.0103	1.6013	.2468

$\text{B} = \text{NaC}_4\text{H}_7\text{O}_2$, Butyrate; $T = 291.3^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0224	1.6497	0.1497
.0066	.0199	1.6389	.1628
.0164	.0169	1.6252	.1825
.0329	.0131	1.6099	.2145
.0658	.0091	1.5832	.2675
.1315	.0060	1.5417	.3708
.263	.0040	1.4857	.5167
.493	.0027	1.4367	.6953

$\text{AgC}_5\text{H}_9\text{O}_2$, Valerate = $\text{Ag}^+ + \text{C}_5\text{H}_9\text{O}_2^-$
 $\text{B} = \text{AgNO}_3$; $T = 289.6^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0094	2.0268	0.0969
.0067	.0068	2.0185	.1162
.01333	.0051	2.0134	.1358
.0267	.0031	2.0171	.1726
0.1	.0012	1.9578	.3181

$\text{B} = \text{AgC}_2\text{H}_3\text{O}_2$, Acetate; $T = 290.9^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0094	2.0268	0.0969
.0067	.0070	2.0091	.1170
.0135	.0057	1.9804	.1386
.0270	.0037	1.9723	.1752
.0505	.00265	1.9257	.2305

$\text{B} = \text{NaC}_5\text{H}_9\text{O}_2$, Valerate; $T = 291.7^\circ\text{K}$ (26)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0095	2.0223	0.0975
.0175	.0047	1.9908	.1486
.0349	.0030	1.9721	.1947
.0698	.0018	1.9448	.2676
.1395	.0015	1.9373	.3755

$\text{AgC}_7\text{H}_5\text{O}_2$, Benzoate = $\text{Ag}^+ + \text{C}_7\text{H}_5\text{O}_2^-$
 $\text{B} = \text{HNO}_3$; $T = 298.1^\circ\text{K}$ (1086)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01144	1.9416	0.1070
.004435	.01395	1.8557	.1356
.00887	.01698	1.7700	.1608
.008915	.01715	1.7657	.1614
.01774	.02324	1.6337	.2024
.01783	.02351	1.6287	.2034
.02674	.03071	1.5127	.2397

$\text{B} = \text{C}_2\text{H}_2\text{ClO}_2$, Chloroacetic acid; $T = 298.1^\circ\text{K}$ (1086)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.003935	0.01385	1.8585	
.00785	.01612	1.7926	
.01574	.02093	1.6792	

$\text{Ag}_2\text{SO}_4(\text{s}) = 2\text{Ag}^+ + \text{SO}_4^{--}$

$\text{B} = \text{H}_2\text{SO}_4$; $T = 298.1^\circ\text{K}$ (1415); cf. (354)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.02699	1.3681	0.2949
.01451	.02744	1.2995	.3389
.02901	.02782	1.2515	.4365
.05263	.02841	1.1941	.4930

$\text{B} = \text{HNO}_3$; $T = 298.1^\circ\text{K}$ (1415)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.01589	0.02993	1.3233	0.3251
.03178	.3266	1.2853	.3603
.06357	.3795	1.2201	.4212

$T = 298.1^\circ\text{K}$ (629, 630)

m_B	s_A	d	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.02684	1.0054	1.3705	0.2838
1.043	.1138	1.0610	0.7432	1.177
2.163	.1688	1.1069	.5718	1.634

B = HNO₃—(Continued)

m_B	S_A	d	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
4.568	0.2633	1.1871	0.3788	2.315
4.861	.2754	1.1956	.3593	2.385
6.764	.3317	1.2456	.2786	2.785
10.423	.3803	1.3326	.2191	3.400
15.311	.4515	1.3676	.1446	4.082

B = (NH₄)₂SO₄

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 289.6^\circ\text{K} (^{53})$			
0.7522	0.02851	0.8651	1.530
1.468	.03492	.7929	2.124
2.206	.03903	.6213	2.595
2.944	.040825	.5670	2.994
3.634	.04162	.5313	3.320
4.26	.04137	.5103	3.592
5.0386	.04015	.4949	3.903
5.51	.03919	.4821	4.080
$T = 304.1^\circ\text{K} (^{53})$			
0.0	0.02941	1.3307	0.2970
.7438	.03531	0.8035	1.529
1.46	.04269	.6534	2.123
2.204	.04811	.5603	2.599
2.898	.05083	.5053	2.974
3.448	.05192	.4744	3.391
4.344	.05218	.4406	3.623
5.066	.05131	.4228	
5.922	.04993	.4083	4.233
$T = 324.1^\circ\text{K} (^{53})$			
0.0	0.03441	1.2626	0.3212
.7505	.04369	0.7391	1.543
1.5007	.05388	.5811	2.160
2.243	.06052	.4906	2.628
3.006	.0635	.4350	3.035
3.689	.0661	.3942	3.357
3.829	.06719	.3805	3.463
5.015	.06677	.3475	3.905
5.769	.06590	.3313	4.184
6.442	.06497	.3196	4.418
$T = 348.1^\circ\text{K} (^{53})$			
0.0	0.04018	1.1953	0.3471
.7316	.06193	0.6382	1.540
1.395	.08364	.4609	2.106
2.244	.1062	.3250	2.650
3.098	.127	.2252	3.110
3.715	.1389	.1755	3.400
5.109	.1615	.0866	3.976
6.644	.182	.0145	4.525
6.943	.1838	.0054	4.624
$T = 373.1^\circ\text{K} (^{53})$			
0.0	0.04531	1.1607	0.3612
0.7885	.08043	0.5484	1.615
1.378	.1022	.4230	2.098
2.223	.1316	.2628	2.658
2.933	.153	.1797	3.043
4.299	.1912	.0609	3.670
5.091	.2102	.0094	3.987
6.425	.2377	−0.0592	4.471
7.28	.2505	−0.0921	4.754

B = AgNO₃; $T = 298.1^\circ\text{K} (^{570})$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.02684	1.3705	0.2838
.02501	.01958	1.3645	.2894
.05009	.01429	1.3511	.3049
.1002	.00853	1.3102	.3546

B = MgSO₄; $T = 298.1^\circ\text{K} (^{570})$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.01004	0.02619	1.3341	0.3587
.02511	.02555	1.2927	.4208
.05019	.02506	1.2412	.5253
.10027	.02489	1.1722	.6897

B = Mg(NO₃)₂; $T = 298.1^\circ\text{K} (^{570})$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.01245	0.02989	1.3237	0.3564
.02500	.03243	1.2883	.4151
.05038	.03683	1.2331	.5115

B = Na₂SO₄

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 287.6^\circ\text{K} (^{51})$			
0.0	0.02358	1.4267	0.2660
.3715	.02376	1.0164	1.089
.7112	.02899	0.8680	1.490
.9183	.03217	.8017	1.689
$T = 291.1^\circ\text{K} (^{53})$			
0.0	0.02456	1.4091	0.2714
.0176	.02283	1.3580	.3483
.0359	.02187	1.3188	.4163
.05209	.02165	1.2865	.4703
.07039	.02133	1.2591	.5246
.1042	.02149	1.2113	.6140
.176	.02210	1.1374	.7709
.214	.02254	1.1061	.8423
.3513	.02463	1.0132	1.061
.711	.02989	0.8590	1.491
.9179	.03297	.7945	1.689
$T = 304.1^\circ\text{K} (^{53})$			
0.0176	0.02761	1.2868	0.3682
.0359	.02678	1.2484	.4343
.05279	.02646	1.2179	.4876
.1056	.02629	1.1461	.6290
.1746	.02723	1.0743	.7780
.3759	.03117	0.9002	1.105
.7075	.03688	.7975	1.494
1.0686	.04233	.6996	1.826
1.789	.04964	.5806	2.349
2.776	.04689	.5350	2.770
3.307	.02989	.6460	3.164
$T = 324.1^\circ\text{K} (^{53})$			
0.0176	0.0331	1.2495	0.3494
.03449	.03239	1.1839	.4479
.04787	.03207	1.1609	.4897
.0718	.03191	1.1247	.5578
.1063	.03213	1.0809	.6381
.1732	.03316	1.0041	.7867
.2780	.03537	0.9348	.9696
.7117	.04422	.7427	1.506
1.773	.05731	.5396	2.343
2.473	.05538	.5049	2.734
3.130	.02828	.6651	3.078
$T = 348.1^\circ\text{K} (^{53})$			
0.01408	0.03896	1.166	0.3989
.03308	.03874	1.1217	.4642
.0563	.03868	1.0851	.5337
.06899	.03880	1.0625	.5687
.107	.03919	1.0155	.6623

Ag₂SO₄—(Continued)**B = Na₂SO₄—(Continued)**

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 348.1^\circ\text{K}.$ —(Continued)			
0.176	0.04069	0.9476	0.8063
.378	.04676	.8100	1.129
.6906	.05442	.6847	1.495
1.406	.06202	.5487	2.099
1.799	.06933	.4813	2.367
2.911	.03707	.5968	2.974
$T = 373.1^\circ\text{K} \text{ (53)}$			
0.0352	0.04300	1.0792	0.4843
.0711	.04371	1.0189	.5869
.1014	.04432	0.9804	.6611
.1366	.04547	.9407	.7391
.2126	.04791	.8727	.8840
.3752	.05295	.7425	1.259
.7145	.06452	.6289	1.529
1.093	.07414	.5302	1.871
1.792	.0754	.4574	2.367
2.091	.07248	.4475	2.547
2.827	.03714	.2671	2.941

B = KNO₃; $T = 298.1^\circ\text{K} \text{ (570)}$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.02502	0.02898	1.3372	0.3450
.05006	.03075	1.3115	.3772
.1016	.03456	1.2609	.4531

B = KHSO₄; $T = 298.1^\circ\text{K} \text{ (1415)}$

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02632	0.02609	1.2818	0.3964
.05263	.02588	1.2238	.4853

B = K₂SO₄

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 287.6^\circ\text{K} \text{ (53)}$			
0.1911	0.02203	1.1277	0.7996
.3460	.02511	1.0096	1.055
.5251	.02877	0.9122	1.289
.5939	.03037	.8792	1.369

 $T = 298.1^\circ\text{K} \text{ (570)}$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.01256	0.02543	1.3359	0.3375
.02513	.02478	1.3041	.3865
.05025	.02414	1.2537	.4725
.1007	.02432	1.1763	.6124

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
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 $T = 298.1^\circ\text{K} \text{ (1415)}$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.01359	0.02545	1.3316	0.3424
.02717	.02465	1.2999	.3943

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
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 $T = 304.1^\circ\text{K} \text{ (53)}$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.1926	0.02885	1.0440	0.4416
.3451	.03226	0.9346	1.064
.5302	.03701	.8358	1.304
.6749	.04047	.7762	1.465
.7776	.04336	.7365	1.569

 $T = 324.1^\circ\text{K} \text{ (53)}$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.1957	0.03499	0.9823	0.8319
.3451	.03874	.8691	1.073
.5335	.04426	.7813	1.316
.6839	.04875	.7184	1.486
.8843	.05445	.6511	1.678
.9801	.05811	.6177	1.765

B = K₂SO₄—(Continued)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 348.1^\circ\text{K} \text{ (53)}$			
0.1873	0.04270	0.9550	0.758
.3540	.04855	.8079	1.099
.5371	.05535	.7130	1.333
.6892	.06080	.6517	1.500
.8889	.06821	.5830	1.695
1.0364	.07559	.5470	1.826
1.210	.08011	.4933	1.967
$T = 373.1^\circ\text{K} \text{ (53)}$			
0.1945	0.05009	0.8700	0.8566
.3466	.05791	.7552	1.102
.5408	.0676	.6512	1.351
.7483	.07831	.5642	1.575
.9342	.08758	.5014	1.751
1.048	.09364	.4659	1.850
1.257	.1037	.4118	2.020
1.354	.109	.3859	2.095

Ag₂C₂O₄(s), Oxalate = 2Ag⁺ + C₂O₄²⁻**B = HNO₃; $T = 298.1^\circ\text{K} \text{ (629, 630)}$**

c_B	s_A	$d_{298.1}$
0.2513	0.008853	1.008
.5025	.01411	1.0186
.9608	.02449	1.0339
1.925	.04720	1.0647
3.986	.1192	1.1415
5.534	.1998	1.1996
5.829	.2230	1.2162

Ag₂S·AgNO₃(s) = 3Ag⁺ + S²⁻ + NO₃⁻**B = AgNO₃; see p. 273****AuI (s) = Au⁺ + I⁻****B = KI; see p. 273****MnC₂O₄·2H₂O(s), Oxalate = Mn⁺⁺ + C₂O₄²⁻ + 2H₂O(l)****B = H₂SO₄; $T = 298.1^\circ\text{K} \text{ (593)}$**

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0125	0.0128	1.8928	0.2978
.025	.0195	1.7099	.3912
.050	.0317	1.4989	.5261
.124	.0619	1.2083	.7872
.245	.1048	0.9796	1.074
.478	.1815	.7411	1.470
.696	.2482	.6052	1.726
.884	.3080	.5114	1.971
.989	.3376	.4716	2.078
1.079	.3572	.4470	2.160

B = H₂C₂O₄, Oxalic acid; $T = 298.1^\circ\text{K} \text{ (593)}$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0125	0.00530	2.0126	0.2423
.025	.0065	1.8443	.3178
.05	.00755	1.6810	.4245
.125	.00976	1.4405	.6426
.25	.0119	1.2524	.8931
.49	.0145	1.0679	1.236

B = (NH₄)₂C₂O₄, Oxalate; $T = 298.1^\circ\text{K} \text{ (593)}$

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.005	0.00237	2.3788	0.1565
.025	.00335	2.0089	.2973
.05	.00562	1.7525	.4153
.125	.0125	1.3823	.6519

B = (NH₄)₂C₂O₄—(Continued)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.245	0.0278	1.0600	0.9198
.245	.0280	1.0583	.9203
.281	.0325	0.9959	.9904

[CoCl₂(NH₃)₄]Br(s) = [CoCl₂(NH₃)₄]⁺ + Br⁻B = C₂HCl₃O₂, Trichloroacetic acid; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00632	2.1993	0.0795
.02	.00681	2.1669	.1636
.05	.00703	2.1547	.239
.1	.00731	2.1361	.327
.2	.00752	2.1238	.455

B = C₂H₂Cl₂O₂, Dichloroacetic acid; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00677	2.1694	0.1636
.05	.00702	2.1537	.239
.1	.00723	2.1409	.327
.2	.00740	2.1308	.455

B = C₂H₃ClO₂, Chloroacetic acid; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00656	2.1831	0.1627
.05	.00673	2.1720	.138
.1	.00677	2.1694	.327
.2	.00685	2.1643	.455

B = C₂H₄O₂, Acetic acid; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00638	2.1952	0.1625
.05	.00642	2.1925	.2375
.1	.00641	2.1934	.326
.2	.00636	2.1965	.454

B = KBr; T = 273.1°K (202)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00635	2.1973	0.0797
.02	.00212	2.1644	.1486
.05	.00107	2.0913	.226
.1	.000635	2.0973	.316

B = KCHO₂, Formate; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00678	2.1688	0.1635
.05	.00720	2.1437	.2390
.1	.00752	2.1238	.328
.2	.00805	2.0966	.456

B = KC₂Cl₃O₂, Trichloroacetate; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00683	2.1656	0.1635
.05	.00719	2.1433	.2390
.1	.00755	2.1221	.328
.2	.00802	2.0968	.456

B = KC₂HCl₂O₂, Dichloroacetate; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00689	2.1618	0.1640
.05	.00725	2.1397	.2393
.1	.00763	2.1175	.328
.2	.00811	2.0910	.456

B = KC₂H₂ClO₂, Chloroacetate; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00687	2.1630	0.1640
.05	.00726	2.1391	.1395
.1	.00764	2.1169	.328
.2	.00818	2.0872	.4562

[CoCl₂(NH₃)₄]IO₃(s) = [CoCl₂(NH₃)₄]⁺ + IO₃⁻

B = NaCl; T = 273.1°K (204, 212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00441	2.3556	0.0670
.02	.00486	2.3134	.1576
.05	.00524	2.2807	.235
.1	.00568	2.2457	.325

B = NaClO₃; T = 273.1°K (204, 212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00491	2.3089	0.1577
.05	.00528	2.2774	.235
.1	.00576	2.2396	.325

B = KCl; T = 273.1°K (204, 212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00487	2.3125	0.1576
.05	.00525	2.2798	.235
.1	.00571	2.2434	.325

B = KClO₃; T = 273.1°K (204, 212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00491	2.3089	0.1577
.05	.00531	2.2749	.235
.1	.00579	2.2374	.326

[CoCl₂(NH₃)₄]NO₃(s) = [CoCl₂(NH₃)₄]⁺ + NO₃⁻

B = HCl; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00383	2.4169	0.0619
.005	.00404	2.3936	.0951
.01	.00410	2.3872	.1187
.05	.00447	2.3497	.233
.1	.00474	2.3242	.3235

B = NaCl; T = 273.1°K (204, 212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0 (204)	0.00386	2.4134	0.01962
.005 (212)	.00395	2.4034	.0946
.01 (212)	.00405	2.3925	.1185
.05 (212)	.00449	2.3478	.2334
.05 (204)	.00451	2.3458	.234
.1 (212)	.00480	2.3186	.3234
.1 (204)	.004835	2.3156	.323

B = NaC₆H₅SO₃, Benzenesulfonate; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.005	0.00394	2.4045	0.0945
.01	.00404	2.3936	.1183
.05	.00445	2.3516	.2331
.1	.00477	2.3215	.3235
.2	.00519	2.2948	.453

B = KCl; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.005	0.00399	2.3991	0.0948
.01	.00408	2.3893	.1186
.03	.00434	2.3625	.1851
.05	.00458	2.3391	.2337
.1	.00496	2.3045	.324
.1 (204)	.00500	2.3010	.324

B = KCHO₂, Formate; T = 273.1°K (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.005	0.00395	2.4035	0.0946
.01	.00409	2.3883	.1186
.05	.00455	2.3420	.2336
.1	.00487	2.3125	.3235
.2	.00533	2.2733	.453
.5	.00635	2.1972	.711
1.0	.00760	2.1192	1.004

[CoCl(NH ₃) ₅]Cl ₂ (s) = [CoCl(NH ₃) ₅] ⁺⁺ + 2Cl ⁻ B = NaCl; T = 273.1°K (204)			
c _B	s _A	log (1/c _±)	μ _c [‡]
0.0	0.0091	1.8403	0.1652
.1	.000593	1.7355	.318
B = KOH; T = 273.1°K (212)			
0.02	0.01090	1.7619	0.2295
.05	.01320	1.6787	.309
.1	.01310	1.6820	.373
B = KCl; T = 273.1°K (204, 212)			
0.1	0.000610	1.7381	0.318
[CoBr(NH ₃) ₅]Cl ₂ (s) = [CoBr(NH ₃) ₅] ⁺⁺ + 2Cl ⁻ B = NaCl; T = 273.1°K (204)			
c _B	s _A	log (1/c _±)	μ _c [‡]
0.0	0.00542	2.0653	0.1275
.1	.000213	1.8894	.317
B = NaClO ₃ ; T = 273.1°K (212)			
0.05	0.00694	1.9579	0.266
.1	.00791	1.9011	.352
1.0	.01511	1.6200	1.205
B = KCl; T = 273.1°K (204)			
0.1	0.000220	1.8844	0.317
B = KClO ₃ ; T = 273.1°K (212)			
0.05	0.00699	1.9558	0.264
.1	.00792	1.9006	.352
[CoCl(NH ₃) ₅]Br ₂ (s) = [CoCl(NH ₃) ₅] ⁺⁺ + 2Br ⁻ B = MgSO ₄ ; T = 273.1°K (212)			
c _B	s _A	log (1/c _±)	μ _c [‡]
0.0	0.00725	1.9390	0.1475
.01	.00916	1.8374	.259
.02	.01027	1.7877	.333
.05	.01245	1.7041	.487
B = Ca(CHO ₂) ₂ , Formate; T = 273.1°K (212)			
0.01	0.00815	1.8881	0.233
.02	.00900	1.8451	.295
.04	.00979	1.8085	.386
.05	.00997	1.8006	.424
B = Na ₂ SO ₄ ; T = 273.1°K (212)			
0.01	0.00903	1.8436	0.239
.02	.01040	1.7823	.302
.05	.01312	1.6814	.435
B = KC ₂ HCl ₂ O ₂ , Dichloroacetate; T = 273.1°K (212)			
0.01	0.00774	1.9106	0.1822
.05	.00938	1.8271	.279
.075	.00980	1.8081	.322
.1	.01016	1.7964	.361
B = K ₂ C ₈ H ₄ O ₄ , Phthalate; T = 273.1°K (212)			
0.01	0.00932	1.8299	0.2405
.02	.01073	1.7697	.304
.05	.01340	1.6722	.436
.1	.01604	1.5968	.590
[CoBr(NH ₃) ₅]Br ₂ (s) = [CoBr(NH ₃) ₅] ⁺⁺ + 2Br ⁻ B = C ₂ HCl ₃ O ₂ , Trichloroacetic acid; T = 273.1°K (212)			
c _B	s _A	log (1/c _±)	μ _c [‡]
0.0	0.00275	2.3600	0.0908
.1	.00372	2.2288	.333
.2	.00411	2.1855	.460

B = NaClO ₃ ; T = 273.1°K (212)			
c _B	s _A	log (1/c _±)	μ _c [‡]
0.02	0.00323	2.2901	0.1724
.05	.00369	2.2323	.247
.1	.00420	2.1760	.335
B = NaCHO ₂ , Formate; T = 273.1°K (212)			
0.02	0.00315	2.3010	0.1715
.05	.00351	2.2540	.246
.1	.00393	2.2039	.333
.2	.00442	2.1539	.462
.5	.00527	2.0775	.718
1.0	.00593	2.0262	1.008
B = KClO ₃ ; T = 273.1°K (212)			
0.02	0.00323	2.2901	0.1724
.05	.00371	2.2299	.247
.1	.00425	2.1709	.335
B = KCHO ₂ , Formate; T = 273.1°K (212)			
0.02	0.00323	2.2901	0.172
.05	.00357	2.2466	.2465
.1	.00397	2.2005	.334
.2	.00455	2.1413	.462
.5	.00549	2.0597	.718
1.0	.00648	1.9877	1.010
B = KC ₂ Cl ₃ O ₂ , Trichloroacetate; T = 273.1°K (212)			
0.1	0.00388	2.2105	0.333
.2	.00444	2.1519	.462
[Co(NO ₂) ₂ (NH ₃) ₄]Cl(s) = [Co(NO ₂) ₂ (NH ₃) ₄] ⁺ + Cl ⁻ B = KCl; T = 273.1°K (199, 202)			
c _B	s _A	log (1/c _±)	μ _c [‡]
0.0	0.02216	1.6544	0.1490
.02	.01515	1.6370	.1875
.05	.01005	1.6097	.2451
.1	.00640	1.5840	.3263
B = KCHO ₂ , Formate; T = 273.1°K (212)			
0.0	0.0222	1.6536	0.1490
.02	.02310	1.6364	.2075
.05	.02400	1.6198	.270
.1	.02520	1.5986	.354
[Co(NO ₂) ₂ (NH ₃) ₄]ClO ₄ (s) = [Co(NO ₂) ₂ (NH ₃) ₄] ⁺ + ClO ₄ ⁻ B = C ₂ HCl ₃ O ₂ , Trichloroacetic acid; T = 273.1°K (212)			
c _B	s _A	log (1/c _±)	μ _c [‡]
0.0	0.01239	1.9069	0.1114
.1	.01398	1.8545	.3372
B = NaCHO ₂ , Formate; T = 273.1°K (212)			
0.05	0.01362	1.8658	0.252
.1	.01420	1.8477	.3375
B = KCHO ₂ , Formate; T = 273.1°K (212)			
0.05	0.01423	1.8468	0.2532
.1	.01566	1.8052	.340
B = KC ₂ Cl ₃ O ₂ , Trichloroacetate; T = 273.1°K (212)			
0.1	0.01562	1.8063	0.340
α[Co(NO ₂) ₂ (NH ₃) ₄]NO ₃ (s) = α[Co(NO ₂) ₂ (NH ₃) ₄] ⁺ + NO ₃ ⁻ B = HNO ₃ ; T = 273.1°K (200)			
c _B	s _A	log (1/c _±)	μ _c [‡]
0.0	0.00546	2.2628	0.0739
.02	.001610	2.2293	.147
.05	.000793	2.1974	.225
.1	.000481	2.1578	.323

B = C₂HCl₃O₂, Trichloroacetic acid; T = 293.1°K (200)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.01483	1.8289	0.1216
.2	.01749	1.7572	.466
.387	.01811	1.7421	.636

B = Pb(NO₃)₂; T = 293.1°K (200)

0.05	0.00346	1.7230	0.391
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B = NaNO₃; T = 293.1°K (200)

0.05	0.00497	1.7867	0.234
.1	.00307	1.7498	.321
.2	.001935	1.6541	.449

B = Na₂C₂O₄, Oxalate; T = 273.1°K (200)

0.02	0.00629	2.2013	0.2572
.05	.00683	2.1656	.3956
.1	.00745	2.1278	.552

B = NaC₆H₅O₃S, Benzenesulfonate; T = 293.1°K (200)

0.2	0.01897	1.7219	0.4675
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B = KOH; T = 273.1°K (200)

0.02	0.00605	2.2182	0.161
.05	.00445	2.3514	.233
.1	.00343	2.4647	.321

B = KNO₃; T = 273.1°K (200)

0.02	0.001654	2.2230	0.147
.05	.000851	2.1819	.225
.1	.000524	2.1393	.3165

B = KCHO₂, Formate

T = 273.1°K (200)

0.02	0.00590	2.2291	0.161
.05	.00633	2.1986	.237
.1	.00684	2.1649	.326
.2	.00760	2.1192	.456

T = 293.1°K (200)

0.05	0.01666	1.7783	0.258
.1	.01772	1.7515	.342
.2	.01926	1.7153	.468
.5	.02298	1.6486	.722

B = KCNS; T = 273.1°K (200)

0.02	0.00601	2.2211	0.161
.05	.00657	2.1824	.238
.1	.00730	2.1367	.327

β[Co(NO₂)₂(NH₃)₄]NO₃(s) = β[Co(NO₂)₂(NH₃)₄]⁺ + NO₃⁻B = HNO₃; T = 273.1°K (200)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.00494	2.3063	0.0702
.02	.001340	2.2718	.146
.05	.000660	2.2379	.225
.1	.000400	2.1981	.316

B = C₂HCl₃O₂, Trichloroacetic acid; T = 293.1°K (200, 212)

0.0	0.01298	1.8867	0.1138
.2	.01545	1.8111	.464
.387	.01601	1.7954	.634

B = Pb(NO₃)₂; T = 293.1°K (200)

0.05	0.00274	1.6892	0.3904
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B = NaNO₃

T = 273.1°K (200)

0.0 (206)	0.00501	2.3002	0.0714
.02	.00138	2.2651	.146
.05	.000706	2.2231	.225

B = NaNO₃.—(Continued)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.1 (206)	0.000409	2.1854	0.316
.1	.000436	2.1794	.316
T = 278.12°K (206)			
0.0	0.00645	2.1904	0.0802
.1	.000666	2.0743	.316
T = 283.16°K (206)			
0.0	0.00821	2.0857	0.0904
.1	.00104	1.9795	.317
T = 288.17°K (206)			
0.0	0.0104	1.9820	0.102
.1	.001609	1.8643	.317
T = 293.1°K (200, 206)			
0.0 (206)	0.01306	1.8841	0.114
.0	.01298	1.8867	.1138
.05	.00390	1.8387	.232
.1	.00243	1.8070	.319
.1 (206)	.00244	1.7589	.318
.2	.001515	1.7626	.448

B = NaC₆H₅O₃S, Benzenesulfonate; T = 293.1°K (200)

0.2	0.01672	1.7768	0.465
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B = Na₂C₂O₄, Oxalate; T = 273.1°K (200)

0.02	0.00572	2.2424	0.256
.05	.00621	2.2069	.395
.1	.00678	2.1688	.552

B = KOH; T = 273.1°K (200, 212)

0.02	0.00553	2.2573	0.1595
.05	.00405	2.3925	.232
.1	.00311	2.5072	.320

B = KNO₃

T = 273.1°K (200)

0.0	0.00501	2.3002	0.0714
.02	.001376	2.2658	.146
.05	.000706	2.2231	.225
.1 (206)	.000441	2.1684	.316
.1	.000436	2.1799	.317

T = 278.12°K (206)

0.1	0.000698	2.0635	0.316
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T = 283.16°K (206)

0.1	0.001098	1.9573	0.317
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T = 288.17°K (206)

0.1	0.001694	1.8498	0.317
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T = 293.1°K (206)

0.1	0.00256	1.7964	0.318
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B = KCHO₂, Formate

T = 273.1°K (199, 200, 202)

0.02	0.00536	2.2708	0.1593
.05	.00575	2.2403	.236
.1	.00621	2.2069	.3258
.2	.00693	2.1593	.455

T = 293.1°K (199, 200, 202)

0.05	0.01467	1.8336	0.254
.1	.01571	1.8038	.340
.2	.01713	1.7662	.4655
.5	.02035	1.6893	.721

B = KCNS; T = 273.1°K (200, 212)

0.02	0.00546	2.2628	0.1597
.05	.00596	2.2247	.2365
.1	.00663	2.1785	.3265

$[\text{CoCl}(\text{NH}_3)_5](\text{NO}_3)_2(\text{s}) = [\text{CoCl}(\text{NH}_3)_5]^{++} + 2\text{NO}_3^-$ B = NaNO_3 ; $T = 273.1^\circ\text{K}$ (204)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.003670	1.4580	0.333
B = KNO_3 ; $T = 273.1^\circ\text{K}$ (204)			
0.1	0.00397	1.4451	0.334
$[\text{CoNO}_2(\text{NH}_3)_5](\text{NO}_3)_2(\text{s}) = [\text{CoNO}_2(\text{NH}_3)_5]^{++} + 2\text{NO}_3^-$ B = MgCl_2 ; $T = 273.1^\circ\text{K}$ (212)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0170	1.5689	0.226
.01	.0185	1.5321	.292
B = Na_2SO_4 ; $T = 273.1^\circ\text{K}$ (212)			
0.01	0.0197	1.5058	0.298
.02	.0221	1.4549	.382
.05	.0272	1.3646	.481
.1	.0336	1.2730	.633
B = KCl ; $T = 273.1^\circ\text{K}$ (212)			
0.01	0.01784	1.5479	0.252
.02	.01858	1.5303	.275
B = $\text{KC}_2\text{HCl}_2\text{O}_2$, Dichloroacetate; $T = 273.1^\circ\text{K}$ (212)			
0.02	0.0184	1.5345	0.274
.05	.0201	1.4961	.332
.1	.0215	1.3669	.4105
$[\text{Co}(\text{NH}_3)_6](\text{NO}_3)_3(\text{s}) = [\text{Co}(\text{NH}_3)_6]^{+++} + 3\text{NO}_3^-$ B = NaNO_3 ; $T = 273.1^\circ\text{K}$ (204)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.00450	1.2954	0.3744
B = KNO_3 ; $T = 273.1^\circ\text{K}$ (204)			
0.1	0.00493	1.2818	0.364
$[\text{CoCl}_2(\text{NH}_3)_4]\text{CNS}(\text{s}) = [\text{CoCl}_2(\text{NH}_3)_4]^+ + \text{CNS}^-$ B = MgSO_4 ; $T = 273.1^\circ\text{K}$ (212)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00289	2.5391	0.0538
.02	.00340	2.4685	.2887
.05	.00358	2.4461	.451
.1	.00379	2.4214	.635
.2	.00400	2.3979	.896
B = NaCl ; $T = 273.1^\circ\text{K}$ (204, 212)			
0.0 (204)	0.00282	2.5498	0.0531
.02	.00313	2.5045	.1520
.05	.00332	2.4789	.231
.1	.00353	2.4522	.322
B = NaClO_3 ; $T = 273.1^\circ\text{K}$ (199, 202)			
0.01	0.00306	2.5143	0.1142
.02 (212)	.00316	2.4003	.152
.03	.00327	2.4855	.1825
.05	.00339	2.4698	.2310
.05 (212)	.00337	2.4724	.231
.1 (204)	.003605	2.4431	.321
B = KCl ; $T = 273.1^\circ\text{K}$ (204, 212)			
0.0	0.00282	2.5498	0.0531
.02	.00314	2.5131	.1520
.05	.003355	2.4743	.231
.1	.003580	2.4461	.322
.2	.00389	2.4101	.451
B = KClO_3 ; $T = 273.1^\circ\text{K}$ (204, 212)			
0.0	0.00282	2.5498	0.0531
.02	.00318	2.4976	.1522
.05	.00339	2.4698	.231
.1	.003645	2.4383	.318

B = KCHO_2 , Formate; $T = 273.1^\circ\text{K}$ (212)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.01	0.00300	2.5229	0.1140
.03	.00321	2.4935	.182
.05	.00331	2.4802	.231
.1	.00345	2.4622	.321
.2	.00374	2.4272	.451
.5	.00409	2.3883	.710
1.0	.00439	2.3576	1.002
$[\text{CoCNS}(\text{NH}_3)_5](\text{IO}_3)_2(\text{s}) = [\text{CoCNS}(\text{NH}_3)_5]^{++} + 2\text{IO}_3^-$ B = NaCHO_2 , Formate; $T = 273.1^\circ\text{K}$ (212)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00204	2.4897	0.0782
.02	.00230	2.4376	.164
.05	.00268	2.3712	.241
.1	.00312	2.3051	.330
.2	.00367	2.2346	.459
.5	.00488	2.1109	.717
1.0	.00635	1.9965	1.010
B = KOH ; $T = 273.1^\circ\text{K}$ (212)			
0.02	0.00286	2.3427	0.169
.05	.00324	2.2888	.244
.1	.00323	2.2901	.331
$[\text{CoNCS}(\text{NH}_3)_5]\text{SO}_4(\text{s}) = [\text{CoNCS}(\text{NH}_3)_5]^{++} + \text{SO}_4^{--}$ B = MgSO_4 ; $T = 273.1^\circ\text{K}$ (202)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01177	1.9292	0.217
.02	.01005	1.7599	.3494
.05	.00980	1.6161	.489
.1	.01034	1.4712	.664
$[\text{CoC}_2\text{O}_4(\text{NH}_3)_4]\text{Cl}(\text{s}) = [\text{CoC}_2\text{O}_4(\text{NH}_3)_4]^+ + \text{Cl}^-$ B = NaCl ; $T = 273.1^\circ\text{K}$ (204)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.0057	1.6100	0.325
B = KCl ; $T = 273.1^\circ\text{K}$ (204)			
0.1	0.00581	1.6056	0.325
$[\text{CoC}_2\text{O}_4(\text{NH}_3)_4]\text{ClO}_4(\text{s}) = [\text{CoC}_2\text{O}_4(\text{NH}_3)_4]^+ + \text{ClO}_4^-$ B = MgSO_4 ; $T = 273.1^\circ\text{K}$ (212)			
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00510	2.2924	0.0714
.05	.00739	2.1314	.455
.1	.00823	2.0846	.638
B = $\text{C}_2\text{HCl}_3\text{O}_2$, Trichloroacetic acid; $T = 273.1^\circ\text{K}$ (212)			
0.1	0.00607	2.2168	0.325
.2	.00638	2.1952	.454
B = NaCl ; $T = 273.1^\circ\text{K}$ (212)			
0.05	0.00614	2.2118	0.237
.1	.00684	2.1649	.327
B = NaCHO_2 , Formate; $T = 273.1^\circ\text{K}$ (199, 202, 212)			
0.0	0.00508	2.2931	0.0713
.05	.005965	2.2244	.2365
.1	.00640	2.1938	.3265
.2	.00718	2.1439	.455
B = KOH ; $T = 293.1^\circ\text{K}$ (212)			
0.0	0.0140	1.8539	0.1182
.02	.01603	1.7951	.1897
.05	.01814	1.7414	.261
.1	.01808	1.7428	.343

B = KCl; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.05	0.00634	2.1979	0.237
.1	.00712	2.1477	.327

B = KCHO₂, Formate; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.05	0.00616	2.2104	0.237
.1	.00679	2.1681	.327
.2	.00796	2.0991	.451

B = KC₂Cl₃O₂, Trichloroacetate; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.00677	2.1694	0.327
.2	.00781	2.1073	.456

$[\text{CoC}_2\text{O}_4(\text{NH}_3)_4]\text{NO}_3(\text{s}) = [\text{CoC}_2\text{O}_4(\text{NH}_3)_4]^+ + \text{NO}_3^-$
 B = NaNO₃; $T = 273.1^\circ\text{K}$ (204)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.000777	2.0531	0.317

B = KCl; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00658	2.1818	0.0811
.02	.00736	2.1331	.1655
.05	.00803	2.0967	.241
.1	.00905	2.0455	.330

B = KNO₃; $T = 273.1^\circ\text{K}$ (204)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.000816	2.0424	0.317

$[\text{CoCl}(\text{NH}_3)_5]\text{C}_2\text{O}_4(\text{s}) = [\text{CoCl}(\text{NH}_3)_5]^{++} + \text{C}_2\text{O}_4^{--}$
 B = MgSO₄; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.000359	3.4449	0.0379
.02	.00238	2.6234	.2992
.05	.00354	2.4510	.4630
.1	.00608	2.2161	.650
.2	.01150	1.9393	.920
.5	.02040	1.6904	1.442
1.0	.02930	1.5331	2.025

B = KCl; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.000359	3.4449	0.1462
.05	.000528	3.2774	.2285
.1	.000715	3.1467	.320
.15	.000935	3.0392	.392

B = KCHO₂, Formate; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.000849	3.0711	0.321
.2	.001113	2.9535	.452
.5	.001715	2.7657	.712
1.0	.002424	2.6155	1.003

$[\text{CoNO}_2(\text{NH}_3)_5]\text{C}_2\text{O}_4(\text{s}) = [\text{CoNO}_2(\text{NH}_3)_5]^{++} + \text{C}_2\text{O}_4^{--}$
 B = MgSO₄; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0001614	3.7921	0.0254
.02	.00131	2.8827	.292
.05	.00183	2.7375	.455
.1	.00310	2.5086	.642
.2	.00445	2.3516	.904
1.0	.01026	1.9889	2.010

B = KCl; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00028	3.5528	0.145
.05	.000382	3.4179	.227
.1	.000487	3.3125	.319
.2	.000705	3.1518	.450
.5	.001212	2.9165	.710
1.0	.002011	2.6966	1.004

B = KCHO₂, Formate; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.000272	3.5654	0.145
.05	.000356	3.4485	.227
.1	.000455	3.3420	.319
.2	.000612	3.2132	.449
.5	.000967	3.0156	.710
1.0	.001277	2.8938	1.002

$[\text{CoCl}_2(\text{NH}_3)_4]\text{C}_6\text{H}_2\text{N}_3\text{O}_7(\text{s}) = [\text{CoCl}_2(\text{NH}_3)_4]^+ +$
 $\text{C}_6\text{H}_2\text{N}_3\text{O}_7^-$

B = NaCl; $T = 273.1^\circ\text{K}$ (204, 212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.000212	3.6737	0.01456
.02	.000253	3.5969	.1403
.05	.000266	3.5751	.224
.1	.000285	3.5450	.317
.2	.000301	3.5223	.4475
.5	.000338	3.4711	.708
1.0	.000414	3.3930	1.000

B = KCl; $T = 273.1^\circ\text{K}$ (204, 212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.000257	3.5800	0.1424
.05	.000274	3.5622	.2247
.1	.000295	3.5302	.317
.2	.000335	3.4750	.4475
.5	.000418	3.3788	.707
1.0	.000536	3.3708	1.000

$\text{Ti}[\text{Co}(\text{NO}_2)_4(\text{NH}_3)_2](\text{s}) = \text{Ti}^+ + [\text{Co}(\text{NO}_2)_4(\text{NH}_3)_2]^-$
 B = KClO₃; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00259	2.5867	0.0509
.02	.00274	2.5622	.1507
.05	.00287	2.5421	.230
.1	.00298	2.5258	.321

B = KNO₃; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00278	2.5560	0.1507
.05	.00294	2.5317	.230
.1	.00308	2.5114	.321

B = KHCO₂, Formate; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.02	0.00273	2.5638	0.1507
.05	.00285	2.5451	.230
.1	.00287	2.5421	.3204
.15	.00283	2.5482	.391
.2	.00277	2.5575	.450

$[\text{CoCl}(\text{NH}_3)_5]\text{PtCl}_6(\text{s}) = [\text{CoCl}(\text{NH}_3)_5]^{++} + \text{PtCl}_6^{--}$
 B = MgSO₄; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.000091	4.0410	0.01907
.05	.000282	3.5497	.448
.1	.000483	3.3161	.642

B = KCl; $T = 273.1^\circ\text{K}$ (212)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.000092	4.0362	0.01919
.02	.000132	3.8794	.143
.1	.000268	3.5719	.318
.15	.000327	3.4855	.389

$[\text{Co}(\text{NH}_3)_6][\text{Fe}(\text{CN})_6](\text{s}) = [\text{Co}(\text{NH}_3)_6]^{+++} + [\text{Fe}(\text{CN})_6]^{--}$
 B = MgSO₄; $T = 298.1^\circ\text{K}$ (814)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00002925	4.5539	0.0162
.001	.00006506	4.1867	.0677
.005	.0001524	3.8170	.1462
.01	.0002267	3.6445	.2050

[Co(NH₃)₆][Fe(CN)₆].—(Continued)B = BaCl₂; T = 298.1°K (814)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.005	0.00008314	4.0802	0.1255

B = NaCl

T = 273.1°K (212)

0.0	0.0000098	5.0088	0.00939
.1	.0000831	4.0804	.317
1.0	.000791	3.1018	1.002

T = 298.1°K (814)

0.0005	0.00003379	4.4712	0.0284
.001	.00003526	4.4527	.0363
.005	.0000464	4.3335	.0736
.01	.0000624	4.1925	.1028

B = KCl; T = 273.1°K (956) from (212)

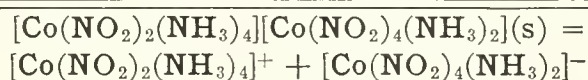
0.05	0.0000534	4.2725	0.224
.1	.0000911	4.0405	.317
.2	.0001724	3.7645	.449
.5	.000462	3.3354	.710
.75	.000751	3.1244	.870
1.0	.001079	2.9670	1.003
2.0	.00272	2.5654	1.423

B = KNO₃; T = 298.1°K (814); cf. (956)

0.0005	0.0000320	4.4948	0.0281
.001	.0000367	4.4353	.0365
.003	.0000427	4.3690	.0582
.005	.0000536	4.2708	.0740
.01	.0000660	4.1805	.1029
.02	.0000880	4.0516	.1442
.03	.0001173	3.9303	.1762
.05	.0001577	3.8022	.2268
.06	.0001799	3.7450	.2482
.07	.0002098	3.6782	.2681
.1	.0002887	3.5496	.3203

B = K₂SO₄; T = 298.1°K (814)

0.001	0.00006224	4.2059	0.0597
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B = NaCl; T = 293.1°K (205, 209)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.00037	3.4318	0.01924
.001	.00138	2.8601	.0488
.002	.00238	2.6234	.0662

B = KCl

T = 273.1°K (212)

0.0	0.000096	4.0177	0.0098
.05	.000124	3.9066	.224
.1	.000132	3.8794	.316
.2	.000149	3.8268	.447
.5	.000202	3.6946	.707

T = 293.1°K (205, 209)

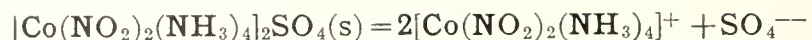
0.001	0.00138	2.8601	0.0488
.002	.00238	2.6234	.0662

B = KNO₃; T = 293.1°K (205, 209)

0.001	0.00138	2.8601	0.0488
.002	.00238	2.6234	.0662

B = KCHO₂, Formate; T = 273.1°K (212)

0.05	0.000119	3.9245	0.224
.1	.000128	3.8928	.316
.2	.000139	3.8570	.447
.5	.000175	3.7570	.707

B = MgCl₂; T = 273.1°K (212)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.00096	2.8170	0.0536
.01	.001326	2.6768	.184
.02	.001500	2.6232	.254
.05	.001855	2.5315	.394
.1	.002235	2.4500	.554

B = Na₂C₂O₄, Oxalate; T = 273.1°K (212)

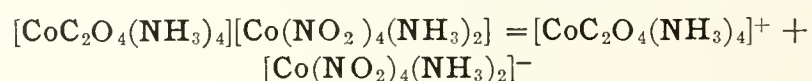
0.01	0.001222	2.7122	0.1835
.025	.001407	2.6510	.284
.05	.00161	2.5924	.393
.1	.001891	2.5226	.552

B = KCl; T = 273.1°K (212)

0.01	0.001115	2.7516	0.1155
.02	.001199	2.7205	.1536
.05	.001385	2.6578	.232
.1	.001612	2.5919	.324

B = KC₂HCl₂O₂, Dichloroacetate; T = 273.1°K (212)

0.02	0.001189	2.7241	0.1535
.05	.001366	2.6638	.2327
.1	.001558	2.6067	.323



B = NaCl

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
T = 273.1°K (212)			
0.0	0.00103	2.9872	0.0321
.02	.001145	2.9412	.1452
.05	.00123	2.9101	.2265
.1	.00137	2.8633	.318

T = 293.1°K (212)

0.0	0.002659	2.4753	0.0515
.1	.003531	2.4521	.321

B = NaNO₃; T = 293.1°K (204)

0.1	0.003615	2.4419	0.3215
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B = NaCHO₂, Formate; T = 273.1°K (212)

0.02	0.00111	2.9547	0.1453
.05	.00120	2.9208	.226
.1	.00128	2.8928	.318

B = KCl

T = 273.1°K (212)

0.02	0.00115	2.9397	0.1454
.05	.00123	2.9101	.226
.1	.00137	2.8633	.3185

T = 293.1°K (204)

0.1	0.003647	2.438	0.3215
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B = KNO₃

T = 273.1°K (212)

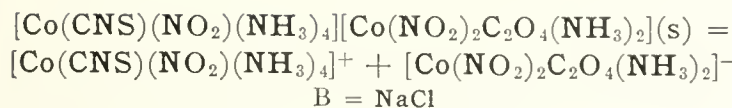
0.02	0.00116	2.9355	0.1455
.05	.00126	2.8996	.2262
.1	.00141	2.8508	.318

T = 293.1°K (204)

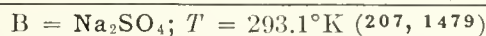
0.1	0.003723	2.4291	0.3215
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B = KCHO₂, Formate; T = 273.1°K (212)

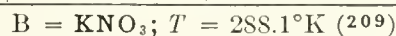
0.02	0.00112	2.9508	0.1452
.05	.00121	2.9172	.2263
.1	.00132	2.8796	.318



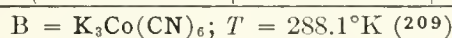
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 288.1^\circ\text{K} \text{ (209)}$			
0.0	0.0003355	3.4743	0.01831
.0003	.0003377	3.4715	.0252
.001	.0003405	3.4679	.0366
.002	.0003451	3.4621	.0484
.01	.0003627	3.4405	.1015
.02	.0003790	3.4214	.1428
$T = 293.1^\circ\text{K} \text{ (207, 1479)}$			
0.0	0.0004449	3.3478	0.0212
.005	.000476	3.3224	.0740
.01	.0004894	3.3103	.1024
.02	.0005051	3.2964	.143
.05	.000540	3.2674	.225
.10	.000571	3.2434	.317



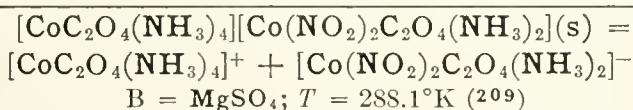
0.0025	0.000481	3.3179	0.0892
.005	.000499	3.3019	.1245
.01	.0005137	3.2893	.1744
.025	.000552	3.2581	.275
.05	.000587	3.2314	.3875



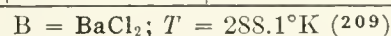
0.001	0.0003418	3.4662	0.0366
.0025	.0003488	3.4574	.0538
.005	.0003572	3.4471	.0732
.01	.0003669	3.4345	.1015



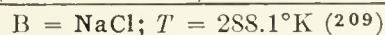
0.00033	0.0003464	3.4604	0.0484
.00067	.0003556	3.4490	.0660
.00167	.0003687	3.4333	.1015



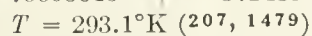
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00049	3.3098	0.0221
.0005	.0005102	3.2923	.0501
.001	.000522	3.2823	.0672
.0025	.0005446	3.2639	.1027
.005	.0005710	3.2434	.1435



0.0005	0.0005059	3.2959	0.0447
.0015	.0005222	3.2822	.0709
.0025	.0005375	3.2696	.0826
.005	.0005649	3.2480	.1245
.01	.0006093	3.2152	.1750



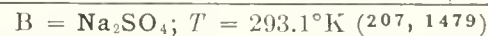
0.0003	0.0004935	3.3067	0.0282
.0007	.0004977	3.3030	.0346
.001	.0005	3.3010	.0387
.002	.0005067	3.2952	.0500
.005	.000522	3.2823	.0743
.008	.0005326	3.2736	.0924
.01	.0005396	3.2679	.1027
.02	.0005646	3.2483	.1434



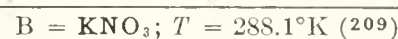
0.0	0.000670	3.1739	0.0259
.005	.0007136	3.1469	.0756
.01	.000739	3.1314	.1036
.02	.0007725	3.1121	.1441



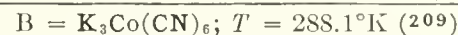
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
$T = 293.1^\circ\text{K} \text{ (Continued)}$			
0.05	0.0008482	3.0715	0.2255
.1	.0009400	3.0269	.3177
.2	.0010800	2.9666	.449
.5	.00144	2.8416	.708
1	.002050	2.6882	1.01



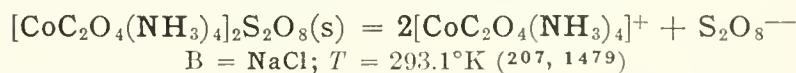
0.0025	0.0007417	3.1298	0.0906
.005	.0007879	3.1035	.1255
.01	.0008496	3.0708	.1752
.025	.0009775	3.0099	.275
.05	.001131	2.9465	.3885
.1	.00134	2.8729	.548
.25	.00178	2.7496	.868
.5	.00231	2.6364	1.226



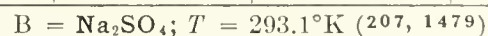
0.001	0.0005	3.3010	0.0387
.0025	.0005088	3.2935	.0549
.005	.0005218	3.2825	.0743
.01	.0005414	3.2665	.1027
.02	.0005725	3.2422	.1434



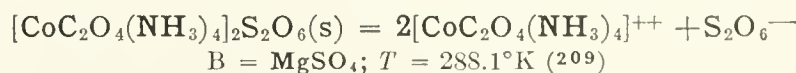
0.0001667	0.0005055	3.2963	0.0388
.0003334	.000515	3.2882	.0502
.0006667	.0005289	3.2764	.0673
.0016667	.0005572	3.2640	.1028



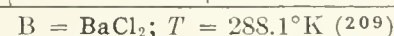
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.000755	2.9214	0.04755
.01	.0008735	2.8580	.112
.02	.0009438	2.8244	.151
.05	.001091	2.7615	.231
.1	.0012956	2.6867	.3210



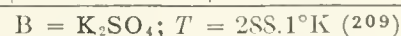
0.005	0.0009505	2.8213	0.1335
.01	.001064	2.7724	.182
.025	.001316	2.6800	.280
.05	.001642	2.5839	.393



c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.0001545	3.6104	0.0215
.0005	.0001652	3.5813	.0500
.001	.0001723	3.5630	.0672
.0025	.0001866	3.5284	.1028



0.0005	0.0001641	3.5842	0.0446
.001	.0001710	3.5663	.0593
.0025	.0001862	3.5293	.0898
.005	.0002032	3.4914	.1249



0.0003	0.0001614	3.5914	0.0372
.0005	.0001630	3.5871	.0446
.0005	.000165	3.5818	.0447
.001	.0001718	3.5643	.0593
.0015	.0001775	3.5501	.0709
.0025	.0001878	3.5256	.0897

[CoC₂O₄(NH₃)₄]₂S₂O₆—(Continued)B = K₃Co(CN)₆; T' = 288.1°K (209)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.00033	0.0001651	3.5816	0.0500
.00067	.0001728	3.5618	.0673
.00167	.0001889	3.5231	.1028

B = NaCl; T = 288.1°K (209)

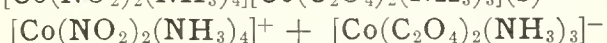
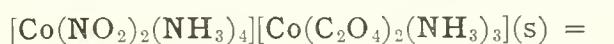
0.001	0.0001597	3.5960	0.0385
.002	.0001645	3.5831	.0500
.005	.0001737	3.5595	.0744
T = 293.1°K (207)			
0.0	0.000201	3.4961	0.0245
.01	.0002382	3.4224	.1035
.02	.0002601	3.3842	.144
.05	.0003675	3.3115	.2253
.1	.0003638	3.2484	.3175

B = Na₂SO₄; T = 293.1°K (207, 1479)

0.005	0.0002597	3.3848	0.1255
.01	.0002945	3.3302	.176
.025	.0003719	3.2389	.276
1.05	.0004563	3.1400	.389

B = KNO₃; T = 288.1°K (209)

0.001	0.0001603	3.5744	0.0385
.005	.0001737	3.5595	.0744
.01	.0001880	3.5251	.1028

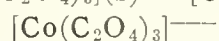
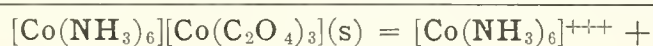


B = KCl; T = 273.1°K (212)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.000593	3.2269	0.0244
.02	.000703	3.1530	.1438
.05	.000790	3.1024	.225
.1	.000917	3.0376	.3274
1.0	.00334	2.4763	1.001

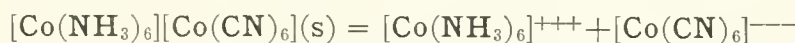
B = KCHO₂, Formate; T = 273.1°K (212)

0.1	0.000895	3.0482	0.316
1.0	.00233	2.6326	1.000



B = NaCl; T = 273.1°K (212)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.000019	4.7212	0.01307
.05	.0001014	3.9940	.2255
.1	.000178	3.7496	.317
.2	.000348	3.4584	.447
.5	.001008	2.9966	.713
1.0	.00245	2.6108	1.010

B = MgSO₄; T = 273.1°K (212)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.000007	5.3548	0.00792
.05	.000243	3.6154	.449
.1	.000390	3.4089	.635
1.0	.00277	2.5574	2.010

B = NaCl; T = 273.1°K (212)

0.05	0.0000378	4.4225	0.224
.1	.0000602	4.2204	.316
.1	.0000651	4.1864	.316
.2	.0001246	3.9045	.448

B = NaCl—(Continued)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.5	0.0003472	3.4694	0.709
1.0	.000602	3.2204	1.004

c _B	Range, 10 ⁵ s _A	log (1/c _±)	μ _c ^{1/2}
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T = 293.1°K (208)

0.0	1.375	4.862	4.862	0.0111
.001	1.69 -1.73	4.772	4.762	.0340
.003	2.11	4.676	4.676	.0565
.005	2.42 -2.49	4.616	4.604	.0723
.010	3.02 -3.22	4.520	4.492	.1002
.015	4.02 -3.83	4.396	4.417	.1239
.020	4.41 -4.70	4.356	4.328	.1428

B = NaCHO₂, Formate; T = 273.1°K (212)

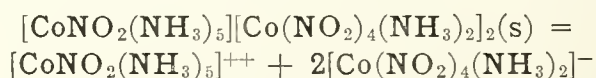
c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.2	0.0001216	3.9151	0.448
.5	.0002632	3.5797	.708
1.0	.0004882	3.3114	1.002

B = KCl; T = 273.1°K (212)

0.05	0.0000379	4.4214	0.2245
.1	.0000650	4.1871	.317
.2	.0001246	3.9045	.448
.5	.000347	3.4597	.710
.75	.000562	3.2503	.868
1.0	.000813	3.0899	1.002
2.0	.00207	2.6840	1.420

B = KCHO₂, Formate; T = 273.1°K (212)

0.2	0.0001377	3.8611	0.448
.5	.0003402	3.4683	.709
1.0	.0007135	3.1466	1.003



B = NaCl (204)

T, °K	c _B	s _A	log (1/c _±)	μ _c ^{1/2}
273.1	0.0	0.000311	3.3065	0.305
273.1	.2	.000621	3.0062	.4485
293.1	.0	.000992	2.8028	.5445
293.1	.2	.001823	2.5385	.453

B = NaCHO₂, Formate (204)

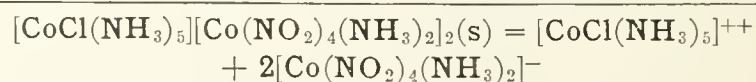
273.1	0.2	0.000570	3.0434	0.448
293.1	0.2	0.001692	2.5707	0.452

B = KCl (204)

273.1	0.2	0.000682	2.9655	0.449
293.1	0.2	0.001952	2.5088	0.453

B = KCHO₂ (204)

273.1	0.2	0.000629	3.0006	0.448
293.1	0.2	0.001824	2.5383	0.452



B = NaCl (204)

T, °K	c _B	s _A	log (1/c _±)	μ _c ^{1/2}
273.1	0.0	0.000173	3.5613	0.02403
273.1	.2	.000353	3.2515	.448
293.1	.0	.000637	2.9952	.0437
293.1	.2	.001187	2.7248	.451

B = NaCHO₂ (204)

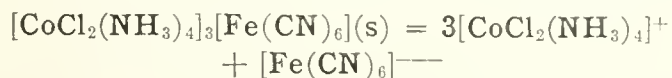
273.1	0.2	0.000325	3.2874	0.447
293.1	0.2	0.001100	2.7579	0.450

B = KCl (204)

T, °K	c _B	s _A	log (1/c _±)	μ _c ^{1/2}
273.1	0.2	0.000393	3.2049	0.448
293.1	0.2	0.001291	2.6884	0.451

B = KCHO₂, Formate (204)

273.1	0.2	0.000363	3.2394	0.448
293.1	0.2	0.001207	2.6176	0.450

B = MgCl₂; T = 273.1°K (212)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.000121	3.5594	0.02695
.005	.000157	3.4463	.1262
.01	.000171	3.4092	.176
.05	.000231	3.2786	.489
.1	.000261	3.2256	.549

B = MgSO₄; T = 273.1°K (212)

0.005	0.000149	3.4690	0.1445
.01	.000167	3.4155	.2025
.05	.000222	3.2958	.448
.1	.000251	3.2425	.634

B = Ca(CHO₂)₂, Formate; T = 273.1°K (212)

0.01	0.000168	3.4169	0.176
.05	.00023	3.2805	.389
.1	.000263	3.2222	.549

B = Na₂SO₄; T = 273.1°K (212, 956)

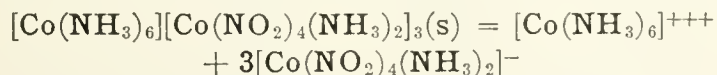
0.005	0.000138	3.5023	0.1256
.01	.000158	3.4435	.176
.05	.000222	3.2958	.389
.1	.000265	3.2190	.549

B = KCl; T = 273.1°K (212)

0.01	0.000139	3.5092	0.104
.05	.000193	3.3466	.226
.1	.000233	3.2748	.318

B = K₂C₈H₄O₄, Phthalate; T = 273.1°K (212)

0.005	0.000144	3.4838	0.1260
.01	.00016	3.4381	.176
.05	.000227	3.2862	.388
.1	.000282	3.1920	.550

B = MgCl₂; T = 273.1°K (212)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.000043	4.0087	0.0161
.01	.0000636	3.8387	.1735
.05	.0000941	3.6686	.388
.1	.0001140	3.5853	.548

B = MgSO₄; T = 273.1°K (212)

0.01	0.000948	3.6654	0.2015
.05	.00144	3.4836	.447
.1	.00173	3.4042	.634

T = 298.1°K (815)

0.0	0.0001651	3.4245	0.03147
.001	.0002218	3.2962	.07301
.005	.0003083	3.1532	.1478
.01	.0003556	3.0912	.2052
.05	.0005446	2.9061	.4508

B = Ca(CHO₂)₂, Formate; T = 273.1°K (212)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.01	0.0000605	3.8604	0.1734
.05	.0000893	3.6913	.388
.1	.0001020	3.6336	.548

B = BaCl₂; T = 298.1°K (815)

0.001	0.0001822	3.3817	0.06397
.003	.0002048	3.3409	.1011
.01	.0002507	3.2430	.1774
.02	.0002893	3.1809	.2484
.03	.0003211	3.1356	.3032
.05	.0003714	3.0724	.3901
.1	.0004653	2.9745	.5503

B = NaNO₃; T = 298.1°K (815)

0.001	0.0001724	3.4057	0.04509
.005	.0001946	3.3531	.07853

B = Na₂SO₄; T = 273.1°K (212)

0.01	0.000101	3.6379	0.175
.05	.000156	3.4491	.389

B = KCl; T = 273.1°K (212)

0.01	0.0000523	3.9237	0.1015
.05	.0000756	3.7637	.2245
.1	.0000960	3.6599	.317

B = KNO₃; T = 298.1°K (956)

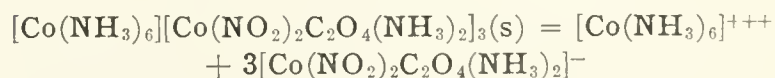
0.001	0.0001719	3.4069	0.04506
.005	.0001976	3.3446	.07864
.05	.0003040	3.1593	.2277
.1	.0003737	3.0697	.3197

B = K₂SO₄; T = 298.1°K (815)

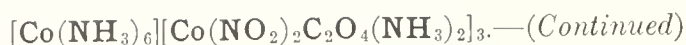
0.001	0.0002302	3.2801	0.06618
.005	.0003271	3.1275	.1302
.01	.0003922	3.0487	.1798
.05	.0006403	2.8358	.3922
.1	.0008320	2.7221	.5522

B = K₂C₈H₄O₄, Phthalate; T = 273.1°K (212)

0.01	0.000110	3.6008	0.175
.05	.000182	3.3821	.389

B = MgSO₄; T = 298.1°K (815)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.00008269	3.7247	0.0227
.0002	.0000941	3.6686	.03693
.0005	.000103	3.6294	.05116
.001	.0001144	3.5838	.06845
.003	.0001436	3.4853	.1134
.004	.0001508	3.4638	.1300
.005	.0001600	3.4381	.1447
.007	.0001715	3.4080	.1704
.02	.0002228	3.2943	.2852
.03	.0002439	3.2550	.3484
.04	.0002666	3.2163	.4020
.05	.0002848	3.1877	.4492
.07	.0003238	3.1419	.5308



$$\text{B} = \text{BaCl}_2; T = 298.1^\circ\text{K} \text{ (815)}$$

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0005	0.00008958	3.6900	0.04513
.001	.00009415	3.6684	.05968
.003	.0001067	3.6140	.09818
.005	.0001165	3.5859	.1252
.01	.0001362	3.5080	.1755
.02	.0001645	3.4260	.2469
.04	.0002109	3.3181	.3480
.05	.0002344	3.2722	.3890
.06	.0002605	3.2264	.4260

$$\text{B} = \text{KNO}_3$$

$T = 288.1^\circ\text{K} \text{ (209)}$			
0.0	0.00005041	3.9397	0.0174
.001	.00005389	3.9107	.0364
.002	.00005661	3.8893	.0483
$T = 298.1^\circ\text{K} \text{ (815)}$			
0.001	0.00008767	3.6993	0.0390
.003	.00009481	3.6653	.0597
.005	.00010101	3.6379	.0749
.01	.00010984	3.6016	.1032
.02	.00012536	3.5439	.1440
.05	.00015796	3.4435	.2257
.1	.00019992	3.3514	.3180

$$\text{B} = \text{K}_2\text{SO}_4; T = 298.1^\circ\text{K} \text{ (815)}$$

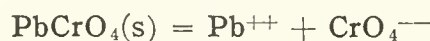
0.0005	0.0001036	3.6268	0.04604
.001	.00011701	3.5740	.06083
.003	.0001484	3.4708	.09945
.005	.0001676	3.4179	.1264
.007	.00018277	3.3802	.1486
.01	.00020339	3.3338	.1767
.02	.0002512	3.2422	.2479
.03	.00028031	3.1946	.3028
.05	.00033625	3.1155	.3898
.07	.00038090	3.0615	.4605
.1	.00043700	3.0017	.5500

$$\text{B} = \text{K}_3\text{Fe}(\text{CN})_6; T = 298.1^\circ\text{K} \text{ (815)}$$

0.001	0.0001290	3.5316	0.0823
.003	.0002121	3.3157	.1388

$$\text{B} = \text{K}_4\text{Fe}(\text{CN})_6; T = 298.1^\circ\text{K} \text{ (815)}$$

0.0005	0.0001793	3.3886	0.07795
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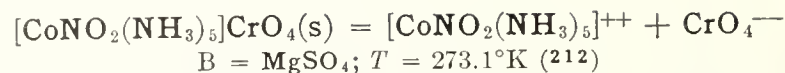


$$\text{B} = \text{HCl}; T = 291.1^\circ\text{K} \text{ (71)}$$

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.1	0.000186	3.7305	0.3175
.2	.000393	3.4056	.4490
.3	.000654	3.1844	.5551
.4	.00107	2.9706	.6358
.5	.00156	2.8069	.7115
.6	.00225	2.6472	.7804

$$\text{B} = \text{HNO}_3; T = 291.1^\circ\text{K} \text{ (71)}$$

0.0	0.073	7.523	0.0001
.1	.000129	3.8894	.3170
.2	.000227	3.6439	.4482
.3	.000312	3.5959	.5479
.4	.000401	3.3969	.6337
.5	.000498	3.3028	.7085
.6	.000598	3.2233	.7761



$$\text{B} = \text{MgSO}_4; T = 273.1^\circ\text{K} \text{ (212)}$$

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0*	0.000258	3.5884	0.0320
.02*	.00062	3.2076	.287
.05*	.000908	3.0419	.451
.1*	.001237	2.9073	.636
.2	.001804	2.7438	.898
1.0	.00512	2.2907	2.005

* See also (199, 202).

$$\text{B} = \text{NaCl}; T = 273.1^\circ\text{K} \text{ (203, 212)}$$

0.05 (212)	0.000415	3.3820	0.227
.05 (203)	.000414	3.3830	.227
.1 (212)	.000565	3.2479	.320
.1 (203)	.000563	3.2495	.319
.2 (212)	.000785	3.1051	.450
.2 (203)	.000781	3.1077	.450
.5 (203)	.001054	2.8229	.708

$$\text{B} = \text{NaClO}_3; T = 273.1^\circ\text{K} \text{ (212)}$$

0.02	0.000318	3.4976	0.145
.05	.000417	3.3799	.227
.1	.000561	3.2510	.320

$$\text{B} = \text{NaNO}_3; T = 273.1^\circ\text{K} \text{ (212)}$$

0.02	0.000344	3.4634	0.145
.05	.000442	3.3546	.227
.1	.000577	3.2388	.320

$$\text{B} = \text{NaCHO}_2, \text{Formate}; T = 273.1^\circ\text{K} \text{ (212)}$$

0.02	0.000323	3.4908	0.145
.05	.00041	3.3872	.227
.1	.000558	3.2534	.320
.2	.000746	3.1273	.450
.5	.001131	2.9465	.710
1.0	.001729	2.7622	1.003

$$\text{B} = \text{KCl}; T = 273.1^\circ\text{K} \text{ (212)}$$

0.02	0.000371	3.4306	0.1465
.05	.00052	3.2840	.228
.1	.00069	3.1612	.321
.2	.000887	3.0521	.450

$$\text{B} = \text{KClO}_3; T = 273.1^\circ\text{K} \text{ (212)}$$

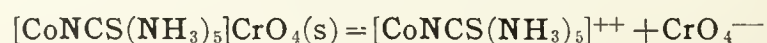
0.02	0.000332	3.4789	0.145
.05	.000421	3.3757	.227
.1	.000570	3.2441	.320

$$\text{B} = \text{KNO}_3; T = 273.1^\circ\text{K} \text{ (212)}$$

0.02	0.000345	3.4622	0.145
.05	.000444	3.3526	.227
.1	.000588	3.2306	.320

$$\text{B} = \text{KCHO}_2, \text{Formate}; T = 273.1^\circ\text{K} \text{ (212)}$$

0.02	0.000361	3.4425	0.1462
.05	.000480	3.3188	.224
.1	.000636	3.1965	.320
.2	.000816	3.0887	.450
.5	.001212	2.9161	.710
1.0	.001787	2.7479	1.003



$$\text{B} = \text{MgSO}_4; T = 273.1^\circ\text{K} \text{ (212)}$$

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.001074	2.9690	0.0655
.02	.00224	2.6498	.297
.05	.00329	2.4828	.4615
.1	.00455	2.4908	.647
.2	.00673	2.1720	.909

B = MgSO₄—(Continued)

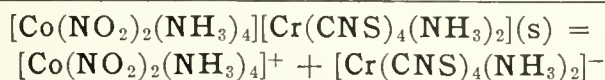
c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.5	0.01150	1.9393	1.430
1.0	.01770	1.7520	2.020

B = NaCHO₂, Formate; T = 273.1°K (212)

0.0	0.00107	2.9706	0.0654
.02	.001377	2.8611	.1594
.05	.001570	2.8141	.237
.1	.001835	2.7364	.327

B = KCHO₂, Formate; T = 273.1°K (212)

0.0	0.00107	2.9706	0.0654
.02	.001402	2.8533	.160
.05	.001628	2.7883	.238
.1	.001898	2.7217	.3275



B = NaCl; T = 293.1°K (205, 209)

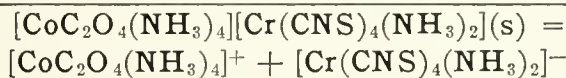
c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0 (205)	0.000143	3.8447	0.01196
.001 (205)	.000115	3.9393	.0334
.001 (209)	.000146	3.8356	.0339

B = KCl; T = 293.1°K (205, 209)

0.001	0.000115	3.9393	0.0334
.001	.000146	3.8356	.0339

B = KNO₃; T = 293.1°K (205, 209)

0.001	0.000115	3.9393	0.0334
.001	.000146	3.8356	.0339



B = NaCl; T = 293.1°K (204, 205, 207, 209, 1479)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0 (204)	0.001366	2.8645	0.0370
0.0 (205)	.00137	2.8633	.0370
0.0 (1479)	.00139	2.8570	.0373
.001 (205)	.00239	2.6214	.0582
.002 (205)	.00340	2.4685	.0735
.005 (1479)	.001446	2.8398	.0803
.01 (1479)	.001489	2.8271	.1072
.02 (1479)	.001554	2.8085	.1468
.05 (1479)	.001644	2.7841	.2272
.1 (204)	.001737	2.7602	.318
.1 (1479)	.00175	2.7570	.3190
.2 (1479)	.001900	2.7212	.449
.5 (1479)	.00212	2.6737	.709
1 (1479)	.00226	2.6459	1.01

B = Na₂SO₄; T = 293.1°K (1479); cf. (207)

0.0025	0.00151	2.8210	0.0949
.005	.00159	2.7986	.1287
.01	.00171	2.7670	.1780
.025	.001903	2.7206	.277
.05	.002123	2.6730	.390
.1	.002669	2.5737	.554
.25	.002720	2.5654	.870
.5	.002770	2.5575	1.228

B = NaNO₃; T = 293.1°K (204)

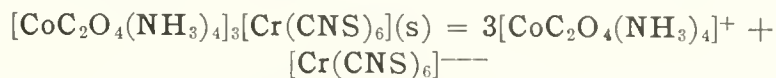
0.1	0.001786	2.7481	0.318
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B = KCl; T = 293.1°K (204, 205, 209)

0.001	0.00239	2.6214	0.0580
.002	.00340	2.4685	.0735
.1 (204)	.001771	2.7518	.318

B = KNO₃; T = 293.1°K (204, 205, 209)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.001	0.00239	2.6214	0.0582
.002	.00340	2.4685	.0735
.1 (204)	.001813	2.7416	.4185

B = MgCl₂; T = 273.1°K (212)

c _B	s _A	log (1/c _±)	μ _c ^{1/2}
0.0	0.000532	2.9163	0.0565
.001	.000577	2.8810	.0804
.005	.000666	2.8187	.1377
.01	.000728	2.7801	.1852
.05	.000954	2.6626	.395

B = MgSO₄; T = 273.1°K (212, 956)

0.001	0.000586	2.8743	0.0867
.005	.000687	2.8052	.155
.01	.000766	2.7580	.211
.05	.001100	2.6008	.455

B = Ca(CHO₂)₂, Formate; T = 273.1°K (212)

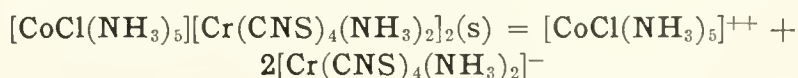
0.001	0.000575	2.8825	0.0803
.005	.000665	2.8194	.1377
.01	.000729	2.7795	.1853
.05	.000954	2.6626	.395

B = NaCl; T = 273.1°K (212)

0.001	0.000549	2.9026	0.0654
.005	.000586	2.8743	.0922
.01	.000627	2.8449	.1172
.05	.000797	2.7407	.234

B = Na₂SO₄; T = 273.1°K (212)

0.001	0.000575	2.8825	0.0803
.005	.000678	2.8110	.138
.01	.000770	2.7557	.186
.05	.001177	2.5734	.396



B = NaCl (204)

T, °K	c _B	s _A	log (1/c _±)	μ _c ^{1/2}
273.1	0.2	0.000524	3.0800	0.448
293.1	0.2	0.001627	2.5879	0.452

B = NaCHO₂, Formate (204)

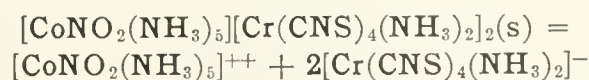
273.1	0.2	0.000477	3.1208	0.448
293.1	0.2	0.001516	2.6286	0.452

B = KCl (204)

273.1	0.2	0.000548	3.0605	0.448
293.1	0.2	0.001702	2.5683	0.4525

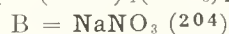
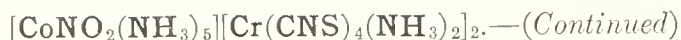
B = KCHO₂, Formate (204)

273.1	0.2	0.000510	3.0917	0.448
293.1	0.2	0.001592	2.6074	0.448

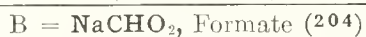


B = NaCl (204)

T, °K	c _B	s _A	log (1/c _±)	μ _c ^{1/2}
273.1	0.0	0.000392	3.2060	0.0342
273.1	.2	.000680	2.9668	.449
293.1	.0	.001284	2.6907	.0620
293.1	.2	.002097	2.4777	.453



$T, ^\circ\text{K}$	c_B	s_A	$\log(1/c_{\pm})$	$\mu_{\pm}^{\frac{1}{2}}$
273.1	0.2	0.000746	2.9266	0.449
293.1	0.2	0.002228	2.4514	0.4545



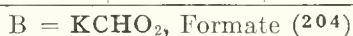
273.1	0.2	0.000629	3.0006	0.449
293.1	0.2	0.001950	2.5093	0.453



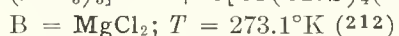
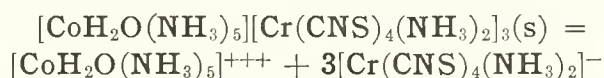
273.1	0.2	0.000723	2.9407	0.449
293.1	0.2	0.002193	2.4573	0.454



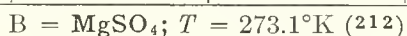
273.1	0.2	0.000790	2.9017	0.4495
293.1	0.2	0.002325	2.4329	0.4548



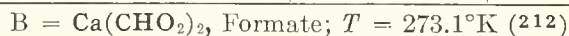
273.1	0.2	0.000667	2.9752	0.449
293.1	0.2	0.002040	2.4897	0.453



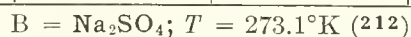
c_B	s_A	$\log(1/c_{\pm})$	$\mu_{\pm}^{\frac{1}{2}}$
0.0	0.0000663	3.8207	0.01994
.005	.0000741	3.7724	.1242
.01	.0000812	3.7326	.1747
.1	.0001184	3.5688	.549



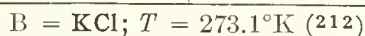
0.01	0.000115	3.5815	0.202
.1	.000186	3.3727	.433



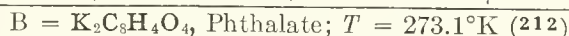
0.005	0.0000861	3.7072	0.1246
.01	.0000976	3.6527	.1747
.05	.0001200	3.5630	.386
.1	.0001360	3.5087	.549



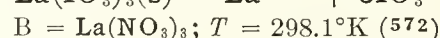
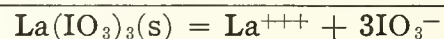
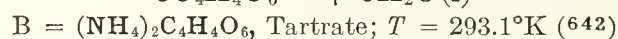
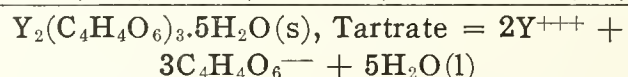
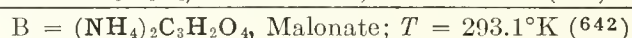
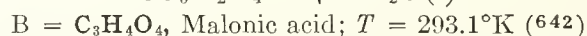
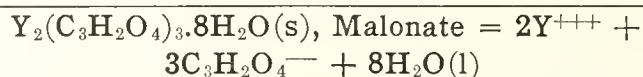
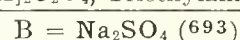
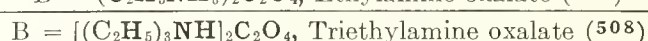
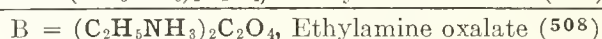
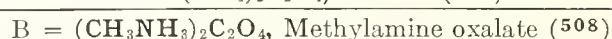
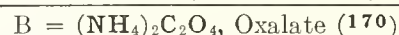
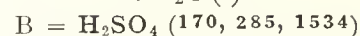
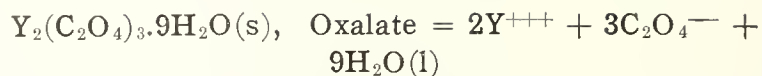
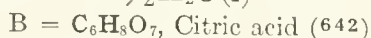
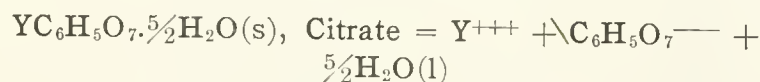
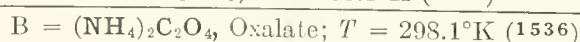
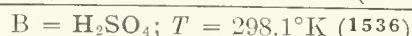
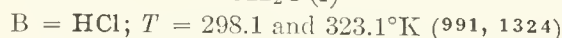
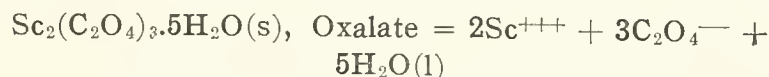
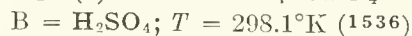
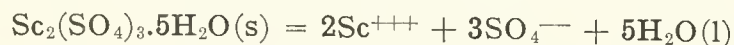
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.01	.000126	3.5418	.1754
.05	.000198	3.3455	.389



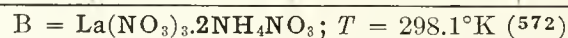
0.01	0.0000732	3.7777	0.102
.05	.0000905	3.6855	.225
.1	.0001024	3.6319	.317



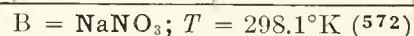
0.005	0.000123	3.5523	0.1254
.01	.000141	3.4930	.1754
.1	.000272	3.2076	.549



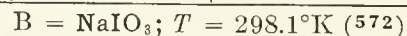
c_B	s_A	$\log(1/c_{\pm})$	$\mu_{\pm}^{\frac{1}{2}}$
0.0	0.001030	2.6293	0.0786
.00066667	.0008430	2.6530	.0979
.0016667	.0007967	2.6181	.1216
.0033333	.0007825	2.5685	.1572
.016667	.0008320	2.3913	.3240
.033333	.0009363	2.2799	.4534
.06684	.0011195	2.1473	.6385



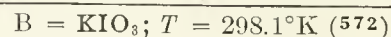
0.005268	0.000951	2.4601	0.2208
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.02107	.0011367	2.2638	.4187
.03161	.0012303	2.1956	.5101
.039366	.0013061	2.1529	.5680
.07873	.0016016	2.0125	.8046
.15747	.0020551	1.8568	1.125
.31495	.0028968	1.5702	1.593



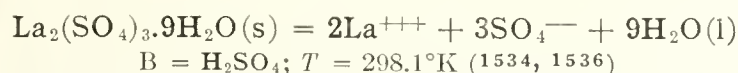
0.001	0.001043	2.6238	0.0852
.002	.001056	2.6185	.0913
.01	.00115	2.5815	.1300
.025	.0013093	2.5250	.1812
.05	.001492	2.4684	.2424
.1	.001748	2.3996	.3324
.2	.0020873	2.3226	.4610
.4	.0024657	2.2502	.6440
.8	.0032487	2.1305	.9052
1.6	.0043114	2.0075	1.275
3.2	.0045657	1.9831	1.796



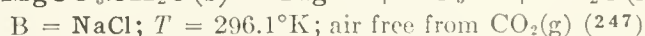
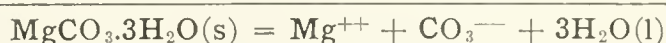
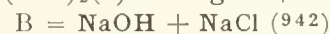
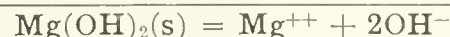
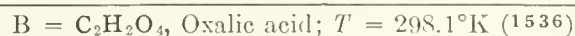
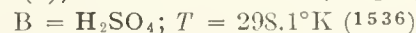
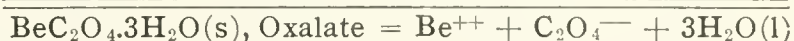
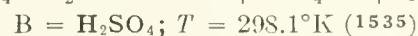
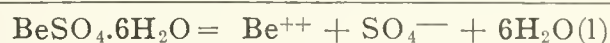
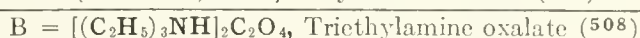
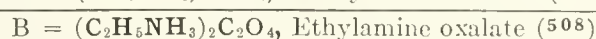
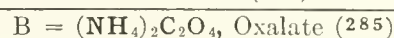
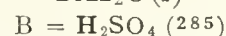
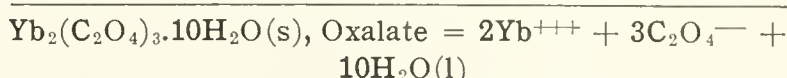
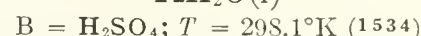
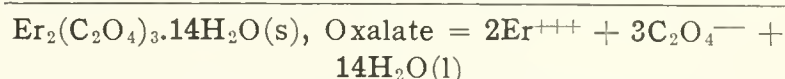
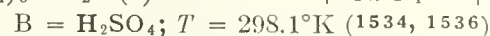
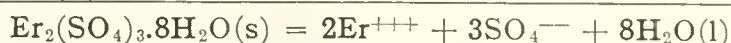
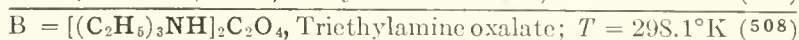
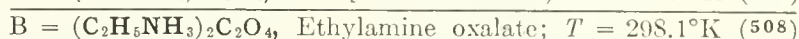
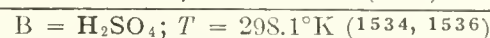
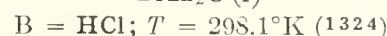
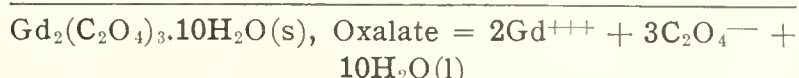
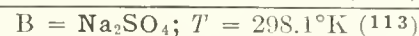
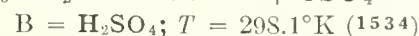
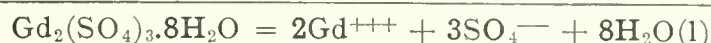
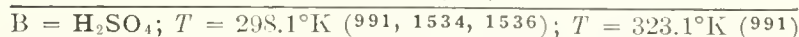
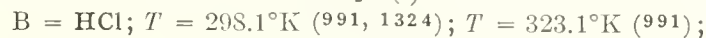
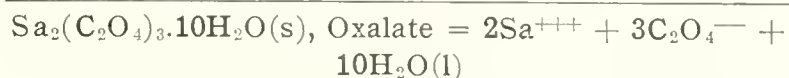
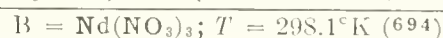
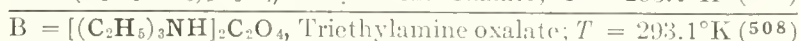
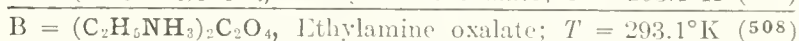
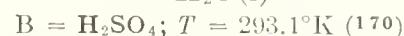
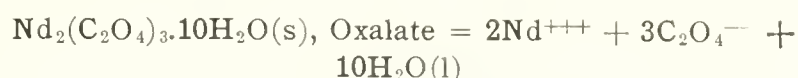
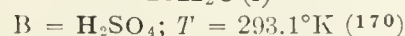
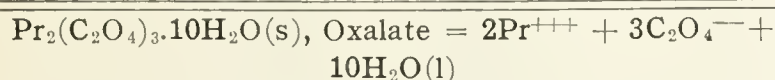
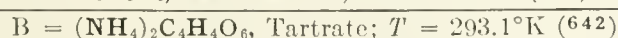
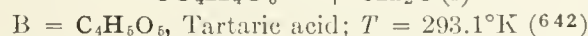
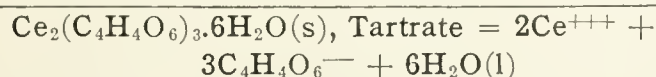
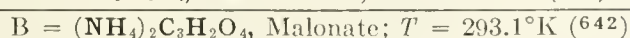
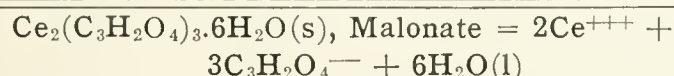
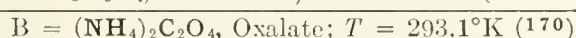
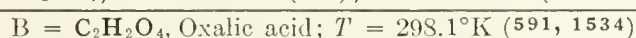
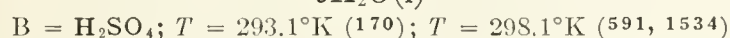
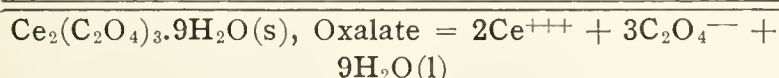
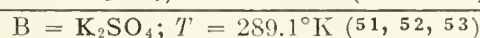
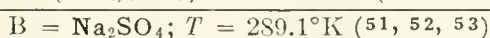
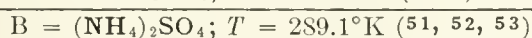
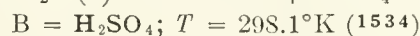
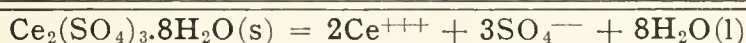
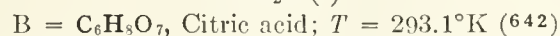
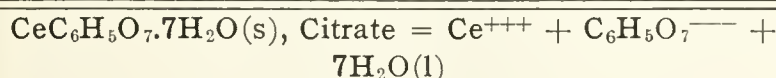
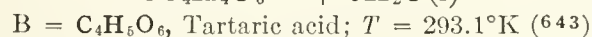
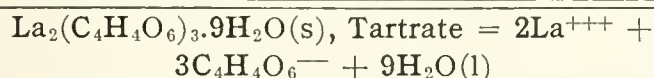
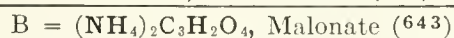
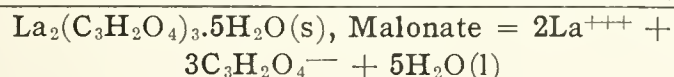
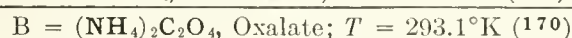
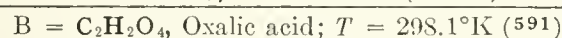
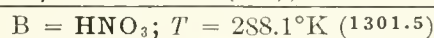
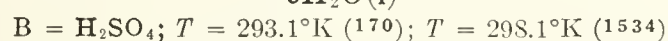
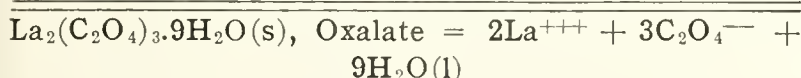
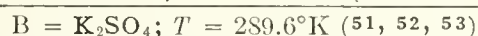
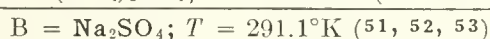
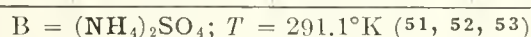
0.0000913	0.0009572	2.6511	0.0764
.000456	.0008507	2.6588	.0746
.000913	.0007658	2.6491	.0756
.001826	.0006016	2.6352	.0737
.003653	.0002973	2.6386	.0725
.004533	.0002017	2.6408	.0758
.006799	.0001468	2.5635	.0877



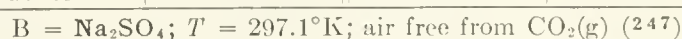
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.0004957	.0008488	2.6555	.0748
.0009914	.0007488	2.6492	.0741
.0019828	.0005632	2.6387	.0724
.0039656	.0002633	2.6371	.0745



m_B	S_A	$\log(1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.04497	0.9404	0.8213
.2624	.05387	.6107	1.263
.5735	.05742	.4525	1.607
1.1608	.05991	.2923	2.093
1.854	.04762	.2282	2.543
2.396	.03774	.2093	2.785
3.873	.01886	.2128	3.450
5.992	.010096	.2100	4.257
8.571	.008912	.1389	5.084
10.84	.007765	.1042	5.715



m_B	S_A	m_B	S_A
0.0	0.002094	1.887	0.00720
0.4846	.005015	2.663	.006816
1.039	.006371	4.339	.005965



m_B	S_A	m_B	S_A
0.0	0.002569	1.165	0.01501
.1776	.006981	1.896	.01670
.3886	.009899	2.076	.01681
.6843	.01229	2.296	.01759

MgCO₃·3H₂O.—(Continued)B = Na₂CO₃; *T* = 298.1°K; air free from CO₂(g) (247)

<i>m</i> _B	<i>S</i> _A	log (1/ <i>m</i> _±)	μ [‡]
0.0	0.002654	2.5761	0.1031
.2188	.003428	1.5591	.8186
.4805	.006069	1.2648	1.211
.8192	.01047	1.0305	1.581
1.213	.01573	0.8569	1.924
1.540	.01969	.7564	2.168
1.745	.02342	.6915	2.309
2.065	.02822	.6143	2.512

For *T* = 308.6°K, *v.* (247)B = KHCO₃; *T* = 288.11, 298.1 and 308.1°K (33, 34)**MgC₂O₄·2H₂O(s), Oxalate = Mg⁺⁺ + C₂O₄[—] + 2H₂O(l)**B = HCl; *T* = 298.1°K (1324)

<i>c</i> _B	<i>S</i> _A	log (1/ <i>c</i> _±)	μ [‡] _c
0.0	0.003426	2.4652	0.1171
.0005	.003778	2.4227	.1229
.001	.004124	2.3847	.1323
.00125	.004293	2.3672	.1357
.0025	.005129	2.2899	.1517
.005	.006793	2.1679	.1794
.01	.010115	1.9960	.2246

B = MgSO₄; *T* = 298.1°K (1489)

<i>m</i> _B	<i>S</i> _A	log (1/ <i>m</i> _±)	μ [‡]
0.0	0.00307	2.5129	0.1108
.00272	.00235	2.4620	.1424
.00491	.00215	2.4094	.1680

Ca(OH)₂(s) = Ca⁺⁺ + 2OH[—]*m* = 0.0210 at 298.1°K (589)B = NH₄Cl; *T* = 298.1°K (1080)

<i>c</i> _B	<i>S</i> _A	log (1/ <i>c</i> _±)	μ [‡] _c
0.0	0.02022	1.4934	0.2463
.02176	.02908	1.3357	.3302
.04532	.03923	1.2057	.4037
.08703	.05968	1.0234	.4886

B = C₃H₅O₃, Glycerol; *T* = 298.1°K (243.5)

<i>m</i> _B	<i>S</i> _A	<i>m</i> _B	<i>S</i> _A
0.0	0.02089	2.372	0.1048
.3946	.03296	5.752	.2422
2.109	.09018	13.70	.5479

B = C₆H₆O, Phenol; *T* = 298.1°K (987.5)

<i>m</i> _B	<i>S</i> _A	<i>m</i> _B	<i>S</i> _A
0.0	0.01666	1.224	1.271
.224	.1288	1.541	1.541
.7126	.7697		

B = CaCl₂; *T* = 298.1°K (1329)

<i>m</i> _B	<i>S</i> _A	log (1/ <i>m</i> _±)	μ [‡]
0.4766	0.018985	1.0486	1.2193
1.002	.02281	0.8903	1.7533
1.61	.02947	.7481	2.2218
2.001	.032308	.6923	2.4697

B = CaBr₂; *T* = 298.1°K (1007)

<i>m</i> _B	<i>S</i> _A	log (1/ <i>m</i> _±)	μ [‡]
0.5124	0.02342	0.9765	1.2677
.7984	.02091	.9479	1.5676
1.189	.02541	.8344	1.9060
1.308	.02072	.8805	1.9964

B = CaI₂; *T* = 298.1°K (1007)

<i>m</i> _B	<i>S</i> _A	log (1/ <i>m</i> _±)	μ [‡]
0.3425	0.01493	1.1655	1.0354
.7184	.01924	0.9872	1.4875
1.184	.02093	.8918	1.9013
1.354	.02417	.8307	2.0333

B = Ca(NO₃)₂; *T* = 298.1°K (59)

<i>m</i> _B	<i>S</i> _A	log (1/ <i>m</i> _±)	μ [‡]
0.0	0.02053	1.4873	0.2482
.2134 (245)	.01342	1.2622	.8248
.31	.01835	1.1181	.9925
.63	.021156	0.9778	1.398
.97456	.02471	.8708	1.752
1.16	.02689	.8214	1.887
1.493	.02985	.7551	2.138
2.217	.03956	.6166	2.602
3.003	.05150	.4964	3.028
4.193	.07346	.3452	3.577
4.901	.09876	.2366	3.873

B = CaSO₄; *T* = 298.1°K (239, 240)

<i>c</i> _B	<i>S</i> _A	log (1/ <i>c</i> _±)	μ [‡] _c
0.0	0.0208	1.4812	0.2498
.002872	.02035	1.4716	.2693
.004892	.02051	1.4563	.2848
.007015	.02167	1.4228	.3051
.008918	.02215	1.4049	.3195
.01167	.02179	1.3989	.3348

B = NaOH; *T* = 293.1°K (318)

<i>m</i> _B	<i>S</i> _A	log (1/ <i>m</i> _±)	μ [‡]
0.0	0.02087	1.4797	0.2502
.01	.01677	1.4996	.2456
.04	.01017	1.4771	.2655
.0666	.006956	1.4486	.2957
.125	.003210	1.4189	.3669
.2	.001962	1.3628	.4537
.5	.0003567	1.3495	.7079

For 323.1, 343.1 and 373.1°K, *v.* (318)

B = NaCl (942)

B = KCl; *T* = 323.1°K (757)

<i>m</i> _B *	<i>S</i> _A *	<i>m</i> _B *	<i>S</i> _A *
0.0	0.029	2.368	0.038
.236	.042	2.841	.036
.947	.045	3.315	.033
1.894	.042	3.552	.017

* Per 1000 g solution.

CaSO₄·2H₂O(s) = Ca⁺⁺ + SO₄[—] + 2H₂O(l)B = HCl; *T* = 298.1°K (919)B = NH₄Cl; *T* = 298.1°K (243)

<i>c</i> _B	<i>S</i> _A	log (1/ <i>c</i> _±)	μ [‡] _c
0.2019	0.02865	1.5428	0.5608
.4561	.03952	1.4031	.7839
.8729	.05194	1.2845	1.040
1.766	.06464	1.1895	1.423
2.798	.07566	1.1211	1.761
3.712	.0797	1.0985	2.008
3.925	.07992	1.0973	2.060
5.140	.07787	1.1086	2.335
6.074	.06905	1.1608	2.520
7.015	.05421	1.2659	2.684

B = NH₄NO₃; *T* = 298.1°K (243)

<i>m</i> _B	<i>S</i> _A	log (1/ <i>m</i> _±)	μ [‡]
0.1249	0.02336	1.6315	0.4672
.3123	.02887	1.5395	.6539
.6871	.04261	1.3704	.9260

B = NH_4NO_3 .—(Continued)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
1.249	0.0572	1.2426	1.234
1.874	.06523	1.1855	1.461
2.498	.07236	1.1405	1.669
3.748	.07934	1.1005	2.016
4.997	.08374	1.0771	2.309
9.369	.08962	1.0476	3.119
12.49	.08675	1.0617	3.583
17.49	.07361	1.1330	4.216

B = $(\text{NH}_4)_2\text{SO}_4$; $T = 298.1^\circ\text{K}$ (1414.5)

0.0009766	0.01500	1.8099	0.2508
.001953	.01466	1.8067	.2540
.007812	.01327	1.7766	.2766
.01563	.01218	1.7350	.3094
.03125	.01131	1.6587	.3728
.06250	.01058	1.5558	.4797
.1250	.01069	1.4192	.6467
.2500	.01188	1.2535	.8930
.7500	.01712	0.9408	1.522
1.500	.02446	.7142	2.144
3.00	.03305	.4995	3.022

B = $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$, Acetate; $T = 298.1^\circ\text{K}$ (952)B = CuSO_4 ; $T = 298.1^\circ\text{K}$ (74, 571)

m_B	s_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0 (571)	0.01535	1.8138	0.2478
.00718	.01521	1.7339	.2993
.01254 (571)	.01360	1.7248	.3233
.0224	.01464	1.6329	.3849
.03793	.0143	1.5634	.4571
.04561	.01365	1.5476	.4869
.05010 (571)	.01239	1.5557	.5000
.09286	.01293	1.4320	.6505
.10100 (571)	.01242	1.4255	.6735
.1236	.01275	1.3799	.7388
.1853	.0124	1.3053	.8893
.21200 (571)	.01329	1.2591	.9492
.2469	.0126	1.2428	1.019
.3094	.01281	1.1922	1.135
.3689	.01309	1.1499	1.236
.6145	.0142	1.0246	1.586
.9227	.0151	0.9245	1.937
.97710 (571)	.01654	.8921	1.994
1.2332	.01531	.8587	2.235
1.4220	.01548	.8263	2.398

B = MgCl_2 ; $T = 299.1^\circ\text{K}$ (246)

0.0	0.01537	1.8133	0.2479
.08947	.03141	1.5029	.6087
.2025	.04203	1.3764	.9890
.4953	.05638	1.1488	1.486
1.3114	.06514	1.1861	2.347
2.289	.05082	1.2939	3.059
3.895	.02239	1.6505	3.958
5.272	.01162	1.9348	4.597

B = MgSO_4 $T = 298.1^\circ\text{K}$ (571)

0.00502	0.01441	1.7762	0.2788
.01012	.01362	1.7451	.3082
.01528	.01310	1.7150	.3369

 $T = 298.1^\circ\text{K}$ (239)

0.0265	0.0119	1.6700	0.3919
.0530	.01106	1.5748	.5061
.0884	.01081	1.4849	.6299

B = MgSO_4 .—(Continued)

m_B	s_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
$T = 298.1^\circ\text{K}$.—(Continued)			
0.1774	0.01086	1.3446	0.8678
.3551	.01142	1.1355	1.370
.5312	.01177	1.0972	1.474
.7144	.01183	1.0330	1.704
1.077	.01208	0.9404	2.087
1.683	.01065	.8719	2.603
2.270	.00809	.8672	3.019
3.114	.00388	.9586	3.532

B = $\text{Mg}(\text{NO}_3)_2$; $T = 298.1^\circ\text{K}$ (1335)

0.0	0.01537	1.8133	0.2487
.09845	.04284	1.3682	.7518
.1985	.05899	1.2292	1.050
.4025	.07525	1.1235	1.382
.8327	.10467	0.9802	1.936
1.2923	.11366	.9444	2.371
1.7976	.12436	.9054	2.773
2.4251	.13374	.8737	3.199

B = $\text{Ca}(\text{OH})_2$; $T = 298.1^\circ\text{K}$ (240)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01562	1.8063	0.2500
.001106	.01491	1.8109	.2509
.003139	.01409	1.8073	.2622
.006224	.01361	1.7844	.2704
.0109	.01265	1.7629	.2886
.01675	.01200	1.7310	.3134
.02179*	.011665	1.7043	.3349

* Solid phase $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}(\text{s}) + \text{Ca}(\text{OH})_2(\text{s})$.B = CaCl_2 ; $T = 298.1^\circ\text{K}$ (246)

0.0	0.01510	1.8210	0.2458
.06747	.009138	1.5792	.4887
.1077	.008675	1.4980	.5981
.2322	.00805	1.3567	.8536
.2887	.007933	1.3141	.9475
.4642	.007463	1.2267	1.193
.8741	.006178	1.1322	1.627
1.736	.003416	1.1130	2.285
2.525	.001491	1.2119	2.753
3.314	.000235	1.5743	3.153

B = $\text{Ca}(\text{NO}_3)_2$; $T = 298.1^\circ\text{K}$ (1338)

m_B	s_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.01534	1.8142	0.2477
.1542	.00921	1.4114	.7066
.3107	.00897	1.2712	.9839
.6303	.00862	1.6295	1.388
1.301	.0073	1.5100	1.983
2.0235	.0062	1.4502	2.465
2.816	.00483	1.4329	2.908
3.679	.00357	1.4405	3.377
4.102	.00315	1.4442	3.508

B = NaCl ; $T = 298.1^\circ\text{K}$ (237)

c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01558	1.8074	0.2497
1.559	.04889	1.3107	1.325
2.463	.05273	1.2779	1.635
2.537	.05262	1.2788	1.657
3.019	.05229	1.2815	1.797
3.913	.04991	1.3018	2.003
4.519	.04773	1.3212	2.170
5.482	.04198	1.3769	2.377

For 288.1, 299.1, 303.1, 335.1, 343.1 and 355.1°K, *v.* (237)

CaSO₄·2H₂O.—(Continued)
 B = NaNO₃; *T* = 298.1°K (1338)

<i>m_B</i>	<i>S_A</i>	log (1/ <i>m_±</i>)	<i>μ</i> ^{1/2}
0.0	0.01534	1.8141	0.2477
.298	.03165	1.4996	.6516
.596	.0413	1.3840	.8726
1.237	.05483	1.2609	1.207
2.544	.06983	1.1559	1.680
4	.07729	1.1118	2.076
9.337	.07664	1.1155	3.105
10.582	.07303	1.1365	3.298

B = Na₂SO₄; *T* = 298.1°K (242)

B = KNO₃; *T* = 298.1°K (571, 1338)

<i>m_B</i>	<i>S_A</i>	log (1/ <i>m_±</i>)	<i>μ</i> ^{1/2}
0.0	0.01534	1.8141	0.2477
.02766 (571)	.01812	1.7419	.3164
.05293 (571)	.02019	1.6949	.3656
.10380 (571)	.02130	1.6715	.4347
.1245	.02432	1.6140	.4710
.2508	.03039	1.5171	.6102
.53	.03952	1.4031	.7669
1.035	.05271	1.2781	1.116
1.587	.06217	1.2064	1.355
2.163	.06986	1.1557	1.563

B = K₂SO₄; *T* = 298.1°K (242)

<i>m_B</i>	<i>S_A</i>	<i>m_B</i>	<i>S_A</i>
0.0	0.01537	1.8133	0.2480
.02808	.01179	1.6639	.3625
.02928	.01149	1.6646	.3658
.05673	.01069	1.5711	.4615
.1638	.01147	1.3506	.7330
.1774	.01164	1.3287	.7608

CaSO₄·2H₂O, Selenite = Ca⁺⁺ + SO₄[—] + 2H₂O(l)
 B = MgSO₄; *T* = 298.1°K (571)

<i>m_B</i>	<i>S_A</i>	<i>m_B</i>	<i>S_A</i>
0.0	0.01521	0.02755	0.01210
0.0	.01514	.05248	.01145
.01114	.01314	.10288	.010985

CaC₂O₄·H₂O(s), Oxalate = Ca⁺⁺ + C₂O₄[—] + H₂O(l)
 B = C₂H₄O₂, Acetic acid; *T* = 299–300°K (612, 613); cf. (599)

<i>c_B</i>	<i>S_A</i>	<i>c_B</i>	<i>S_A</i>
0.0	0.0002325	2.89	0.000793
0.58	0.0006564	5.79	0.000875

CaC₄H₄O₄·H₂O(s), Succinate = Ca⁺⁺ + C₄H₄O₄[—] + H₂O(l)

B = MgC₄H₄O₄, Succinate; *T* = 298.1°K (1491)

<i>m_B</i>	<i>S_A</i>	log (1/ <i>m_±</i>)	<i>μ</i> ^{1/2}
0.0	0.08252	0.5834	0.5745
.04121	.07769	.5172	.6896
.06179	.07474	.4957	.7390
.08230	.07340	.4709	.7892
.1231	.07173	.4273	.8827
.1631	.07087	.3905	.9675

B = Na₂C₄H₄O₄, Succinate; *T* = 298.1°K (1491)

<i>m_B</i>	<i>S_A</i>	log (1/ <i>m_±</i>)	<i>μ</i> ^{1/2}
0.00826	0.08013	0.5748	0.5875
.0506	.07103	.5318	.6602
.1014	.06495	.4830	.7510
.1526	.06138	.4407	.8386
.2560	.05757	.3717	.9992

CaC₄H₄O₆·4H₂O(s), Tartrate = Ca⁺⁺ + C₄H₄O₆[—] + 4H₂O(l)

B = C₂H₄O₂, Acetic acid; *T* = 299–300°K (612, 613)

B = C₄H₆O₆, Tartaric acid; *T* = 291.1°K (1117)

<i>c_B</i>	<i>S_A</i>	<i>c_B</i>	<i>S_A</i>
0.0	0.001462	0.06	0.00810
.00666	.00350	.06667	.00848
.01333	.00447	.07333	.00903
.02	.00517	.08	.00915
.026667	.00581	.086667	.00933
.03333	.00632	.09333	.00967
.04	.00678	.10000	.00989
.04666	.00719	.10666	.0102
.05333	.00758		

B = CaCl₂; Tartrate; *T* = 291.1°K (1117)

<i>c_B</i>	<i>S_A</i>	<i>c_B</i>	<i>S_A</i>
0.00453	0.000776	0.0498	0.000595
.00905	.000699	.0679	.0006573
.0226	.0006531	.0905	.0006804
.0317	.0006381	.2263	.0007004
.0408	.0005916	.4526	.0008614
.0453	.0005927		

B = K₂C₄H₄O₆, Tartrate; *T* = 291.1°K (1117)

<i>c_B</i>	<i>S_A</i>	<i>c_B</i>	<i>S_A</i>
0.0067	0.0006400	0.02	0.0008572
.0091	.0006169	.1	.001011
.01	.0006030	.2	.001172
.0111	.0005762		

Sr(OH)₂·8H₂O(s) = Sr⁺⁺ + 2OH[—] + 8H₂O(l)
 B = SrCl₂; *T* = 298.1°K (1007)

<i>m_B</i>	<i>S_A</i>	log (1/ <i>m_±</i>)	<i>μ</i> ^{1/2}
0.0	0.068	0.9670	0.452
.9113	.09580	.3878	1.738
1.806	.0938	.3916	2.387
3.217	.1606	.1526	3.183

B = SrBr₂; *T* = 298.1°K (1007)

<i>m_B</i>	<i>S_A</i>	<i>m_B</i>	<i>S_A</i>
0.7914	0.07667	0.5634	1.614
1.113	.08053	.5159	1.892
1.534	.08844	.4315	2.206
2.279	.11107	.3095	2.678
2.582	.1259	.2550	2.850
2.808	.1386	.2149	2.973

B = SrI₂; *T* = 298.1°K (1007)

<i>m_B</i>	<i>S_A</i>	<i>m_B</i>	<i>S_A</i>
0.8496	0.07137	0.5755	1.662
1.263	.0736	.5547	2.003
1.929	.08853	.4164	2.460
2.898	.09548	.3207	2.997

B = Sr(SH)₂; *T* = 298.1°K (1007)

<i>m_B</i>	<i>S_A</i>	<i>m_B</i>	<i>S_A</i>
0.5194	0.06338	0.6762	1.322
1.066	.06546	.5709	1.842
1.536	.06026	.5450	2.188
1.855	.06082	.5159	2.397
2.109	.05713	.5162	2.549

B = Sr(NO₃)₂; *T* = 298.1°K (1430)

<i>m_B</i>	<i>S_A</i>	<i>m_B</i>	<i>S_A</i>
0.0	0.08	0.8962	0.490
.0	.085	.8751	.505
.2102	.07527	.7297	.925
.2972	.0762	.6872	1.059
.4233	.07816	.6373	1.227
.6038	.08106	.5815	1.433
.8486	.0878	.5131	1.673
1.126	.09167	.4626	1.911
1.531	.0994	.3969	2.212

B = $\text{Sr}(\text{NO}_3)_2$.—(Continued)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
2.081	0.1158	0.3096	2.567
2.852	.1419	.2059	2.997
3.827	.1698	.1121	3.450

 $\text{SrSO}_4(\text{s}) = \text{Sr}^{++} + \text{SO}_4^{--}$ B = $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$, Acetate; $T = 298.1^\circ\text{K}$ (952)

c_B	S_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.000822	3.0851	0.0574
2.13	.002455	2.6099	1.463
5.34	.003985	2.3995	2.313
10.68	.005128	2.2900	3.268
21.37	.00626	2.2035	4.623

B = MgCl_2 ; Room temp. (1474)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.1701	0.001099	2.959	0.4177
.4412	.001167	2.9329	.6676
1.657	.001525	2.8167	1.290

B = CaCl_2 ; Room temp. (1474)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.8559	0.001047	2.9800	0.9274
1.626	.001208	2.9179	1.277
4.58	.001401	2.8535	2.141

B = NaCl ; Room temp. (1474)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
1.576	0.0009826	3.0076	1.255
3.147	.001409	2.8510	1.776
4.873	.001267	2.8972	2.219

B = KCl ; Room temp. (1474)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
1.134	0.001140	2.9430	1.051
1.923	.001203	2.9197	1.388
2.96	.001670	2.7772	1.723

 $\text{SrC}_2\text{O}_4 \cdot \text{H}_2\text{O}(\text{s})$, Oxalate = $\text{Sr}^{++} + \text{C}_2\text{O}_4^{--} + \text{H}_2\text{O}(\text{l})$ B = $\text{C}_2\text{H}_4\text{O}_2$, Acetic acid; $T = 299-300^\circ\text{K}$ (612, 613)

c_B	S_A	c_B	S_A
0.0	0.000464	3.86	0.003094
.58	.002713	5.79	.002568
1.45	.003208	16.26	.000320
2.89	.003311		

 $\text{SrC}_4\text{H}_4\text{O}_4(\text{s})$, Succinate = $\text{Sr}^{++} + \text{C}_4\text{H}_4\text{O}_4^{--}$ B = $\text{Na}_2\text{C}_4\text{H}_4\text{O}_4$, Succinate; $T = 298.1^\circ\text{K}$ (1489)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.02013	1.6962	0.2838
.00938	.01740	1.6658	.3126
.01875	.01535	1.6552	.3430
.03751	.01322	1.5917	.4067
.05582	.01221	1.5403	.4651
.07457	.01143	1.5037	.5190

 $\text{SrC}_4\text{H}_4\text{O}_5(\text{s})$, Malate = $\text{Sr}^{++} + \text{C}_4\text{H}_4\text{O}_5^{--}$ B = SrCl_2 ; $T = 298.1^\circ\text{K}$ (1489)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.03050	1.5157	0.3493
.01828	.02523	1.4798	.3946
.03103	.02349	1.4464	.4325
.06149	.02019	1.3914	.5150

 $\text{SrC}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}(\text{s})$, Tartrate = $\text{Sr}^{++} + \text{C}_4\text{H}_4\text{O}_6^{--} + 3\text{H}_2\text{O}(\text{l})$ B = $\text{C}_2\text{H}_4\text{O}_2$, Acetic acid; $T = 299-300^\circ\text{K}$ (613)

c_B	S_A	c_B	S_A
0.0	0.00783	3.77	0.03626
.565	.02338	5.65	.03393
1.425	.02978	16.89	.00634
2.85	.03435		

 $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}(\text{s}) = \text{Ba}^{++} + 2\text{OH}^- + 8\text{H}_2\text{O}(\text{l})$ B = BaCl_2 ; $T = 303.1^\circ\text{K}$ (1328)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.3446	0.2619	1.017
.5848	.3282	.1352	1.655
.7492	.3638	.0765	1.827
1.054	.3856	.0234	2.071
1.128	.3923	.0096	2.135

B = BaBr_2 ; $T = 298.1^\circ\text{K}$ (1007)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.2765	0.3576	0.9163
.5478	.2786	.1969	1.575
.7967	.2858	.1504	1.802
1.186	.3196	.0703	2.125
1.375	.3304	.0427	2.262

B = BaI_2 ; $T = 298.1^\circ\text{K}$ (1007)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.6025	0.2717	0.1960	1.620
1.065	.2877	.1162	2.015
1.788	.3069	.0342	2.507
1.905	.3698	−0.0316	2.612

B = $\text{Ba}(\text{NO}_3)_2$; $T = 298.1^\circ\text{K}$ (1110)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
0.0	0.2474	0.4059	0.8615
.01645	.2474	.3966	.8896
.05547	.2509	.3709	.9587
.07192	.2509	.3633	.9841
.09679	.2549	.3463	1.027
.1327	.2584	.3270	1.083
.2165	.2653	.2883	1.202
.2888	.2722	.2598	1.293
.3906	.2843	.2204	1.423
.4392	.2895	.2040	1.478

B = LiCl ; $T = 298.1^\circ\text{K}$ (608)

c_B	S_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.2775	0.3560	0.9112
.75	.3725	.2055	1.366
1.42	.4685	.1286	1.681
2.3	.668	−0.02531	2.074

B = NaOH ; $T = 303.1^\circ\text{K}$ (1328)

m_B	S_A	$\log (1/m_{\pm})$	$\mu^{\frac{1}{2}}$
1.779	0.0899	0.1540	1.431
2.52	.0632	.1187	1.646
3.853	.0427	.0362	1.995
4.787	.0409	.0044	2.216
8.042	.0396	−0.1389	2.857
11.64	.0992	−0.3950	3.454
12.81	.1821	−0.4998	3.654

B = NaCl ; $T = 298.1^\circ\text{K}$ (608)

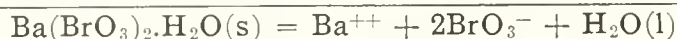
c_B	S_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.73	0.315	0.3010	1.271
1.43	.3495	.2558	1.576
2.82	.403	.1940	2.007

Ba(OH)₂·8H₂O.—(Continued)B = KCl; $T = 298.1^\circ\text{K}$ (608)

c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.86	0.3255	0.2876	1.355
1.75	.330	.2808	1.650
3.4	.388	.2105	2.136

B = RbCl; $T = 298.1^\circ\text{K}$ (608)

1.25	0.324	0.2887	1.491
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B = Mg(NO₃)₂; $T = 298.1^\circ\text{K}$ (570)

m_B	s_A	$\log(1/m_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.02017	1.4946	0.246
.0503	.02644	1.3770	.480

B = Ba(NO₃)₂; $T = 298.1^\circ\text{K}$ (570)

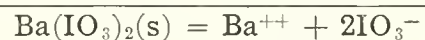
0.01255	0.01846	1.4613	0.305
.02515	.01748	1.4277	.357
.05027	.01641	1.3812	.447
.10064	.01560	1.3035	.5905

B = KBrO₃; $T = 298.1^\circ\text{K}$ (570)

0.02509	0.01332	1.4827	0.255
.05023	.00873	1.4659	.276
.10058	.00441	1.4225	.337

B = KNO₃; $T = 298.1^\circ\text{K}$ (570)

0.02512	0.02204	1.4561	0.302
.05032	.02315	1.4344	.346
.10059	.02627	1.3798	.4235

B = Ba(NO₃)₂; $T = 298.1^\circ\text{K}$ (573)

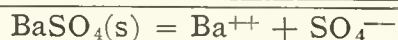
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.000790	2.9017	0.0487
.0005	.000681	2.8867	.0596
.0010	.000606	2.8758	.0694
.0025	.000488	2.8486	.0947
.0100	.000337	2.7757	.1761
.0250	.000307	2.6734	.2751
.0500	.000283	2.5974	.3885
.1000	.000279	2.5017	.548

B = KIO₃; $T = 298.1^\circ\text{K}$ (573)

0.002	0.000812	2.8894	0.0666
.010	.000913	2.8392	.1129
.050	.001320	2.6790	.2322
.200	.001595	2.5964	.453

B = KNO₃; $T = 298.1^\circ\text{K}$ (573)

0.000106	0.000755	2.9017	0.0498
.000530	.000621	2.9033	.0541
.001061	.000471	2.9080	.0595



B = HCl (1104)

B = HNO₃ (1104)B = H₂SO₄; $T = 293.1^\circ\text{K}$ (1512)B = NH₄Cl; $T = 287^\circ\text{K}$ (371)B = NH₄C₂H₃O₂, Acetate; $T = 298.1^\circ\text{K}$ (660, 952)B = FeCl₃; $T = 293-298^\circ\text{K}$ (446)

c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.006164	0.0002485	3.6048	0.1949
.01541	.0003085	3.5107	.306
.03082	.0004927	3.3074	.4225
.06164	.000527	3.2782	.6099
.1541	.0006427	3.1919	.9629

B = FeCl₃.—(Continued)

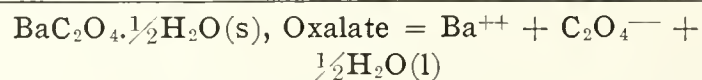
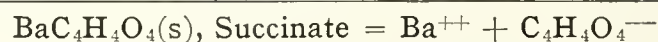
c_B	s_A	$\log(1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.3082	0.0006855	3.1639	1.361
.6164	.0007284	3.1376	1.924

B = AlCl₃; $T = 293-298^\circ\text{K}$ (446)

0.00749	0.0001414	3.8496	0.2135
.01873	.000184	3.7352	.3363
.03746	.0002571	3.5899	.4752
.07492	.0004027	3.3950	.6716
.1873	.000497	3.3037	1.107
.3746	.000728	3.1379	1.500
.7492	.0007498	3.1250	2.121

B = MgCl₂; $T = 293-298^\circ\text{K}$ (446)

0.01045	0.0001285	3.8911	0.1785
.02613	.0001285	3.8911	.2809
.05225	.0001414	3.8495	.3966
.1045	.0001414	3.8495	.5604
.2613	.0002142	3.6692	.8859
.5225	.0002142	3.6692	1.253
1.045	.0002142	3.6692	1.771

B = C₂H₄O₂, Acetic acid; $T = 299-300^\circ\text{K}$ (612)B = NH₄Cl; $T = 289.1^\circ\text{K}$ (253)B = NaCl; $T = 289.1^\circ\text{K}$ (253)B = KCl; $T = 289.1^\circ\text{K}$ (253)B = MgC₄H₄O₄, Succinate; $T = 298.1^\circ\text{K}$ (1489)

m_B	s_A	$\log(1/m_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.01570	1.8041	0.2508
.0077	.01397	1.7276	.2944
.01538	.01294	1.6613	.3366
.03074	.01155	1.565	.4101
.04620	.01065	1.4877	.4770
.06149	.01024	1.4261	.5356

B = CaC₄H₄O₄, Succinate; $T = 298.1^\circ\text{K}$ (1489)

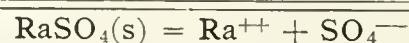
0.00798	0.01383	1.7273	0.2954
.01597	.01275	1.6476	.3389
.03193	.01155	1.5536	.4170

B = Na₂C₄H₄O₄, Succinate; $T = 298.1^\circ\text{K}$ (1489)

0.00798	0.01307	1.7457	0.2761
.01575	.01154	1.6886	.3056
.03149	.00987	1.591	.4049
.04726	.00913	1.4992	.4223

B = C₂H₄O₂, Acetic acid; $T = 299-300^\circ\text{K}$ (612)

c_B	s_A	c_B	s_A
0.0	0.0023	3.77	0.01308
.565	.00806	5.65	.01306
1.425	.01092	16.85	.00153
2.85	.01218		

B = H₂SO₄

c_B	$s_A \times 10^3$	c_B	$s_A \times 10^3$
$T = 298.1^\circ\text{K}$ (893)			
0.0	6.5	10%	7.5
.005	6.3	15%	7.5
.05	6.8	25%	7.1
.5	6.8	30%	7.1

B = H₂SO₄.—(Continued)

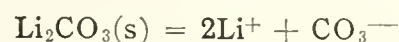
c_B	$s_A \times 10^3$	c_B	$s_A \times 10^3$
45%	5.9	65%	20.0
50%	6.5	70%	>245
55%	10.5	80%	>245
60%	19.5	90%	>245

 $T = 308.1^\circ\text{K}$ (893)

0.005	9.7	25%	10.2
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 $T = 318.1^\circ\text{K}$ (893)

25%	15.5		
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B = NH₄Cl; $T = 298.1^\circ\text{K}$ (469)

c_B	s_A	$\log(1/c_{\pm})^*$	$\mu_{\pm}^{\frac{1}{2}*}$
0.0	0.1708	0.5670	0.7156
.1	.1951	.5090	.8278
.25	.2339	.4302	.9748
.5	.283	.3475	1.161
.75	.3135	.3031	1.300
1	.3405	.2672	1.422
1.5	.3732	.2273	1.619
2	.387	.2116	1.778
4	.3941	.2037	2.276

* Values of $\log(1/c_{\pm})$ and $\mu_{\pm}^{\frac{1}{2}}$ not corrected for hydrolysis.B = (NH₄)₂SO₄; $T = 298.1^\circ\text{K}$ (469)

0.125	0.253	0.3962	1.067
.25	.3932	.2047	1.389
.5	.4902	.1089	1.724
.75	.5545	.0554	1.978
1	.587	.0306	2.182

B = NaCl; $T = 298.1^\circ\text{K}$ (469)

0.1	0.1785	0.5474	0.7922
.25	.1846	.5331	.8965
.5	.1934	.5128	1.039
.75	.1978	.5030	1.159
1.0	.1973	.5043	1.262
1.5	.1951	.509	1.444
2	.1888	.5233	1.602

B = Na₂SO₄; $T = 298.1^\circ\text{K}$ (469)

0.25	0.2206	0.4556	1.188
.5	.2463	.4078	1.496
.1	.2767	.3573	1.957

B = KCl; $T = 298.1^\circ\text{K}$ (469)

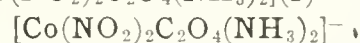
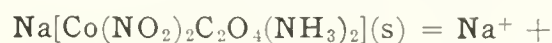
0.1	0.1777	0.5496	0.7957
.25	.1795	.5453	.8880
.5	.1891	.5227	1.033
.75	.1916	.5169	1.151
1.00	.1918	.5164	1.255
1.50	.1866	.5284	1.435
2.0	.1779	.5442	1.592

B = KNO₃; $T = 298.1^\circ\text{K}$ (469)

0.0	0.17075	0.5670	0.7157
.25	.1824	.5383	.8928
.5	.1844	.5335	1.026
.75	.1838	.5349	1.141
1	.1828	.5373	1.244
1.5	.1745	.5575	1.422
2.0	.1634	.5860	1.578

B = K₂SO₄; $T = 298.1^\circ\text{K}$ (469)

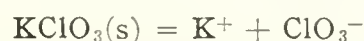
c_B	s_A	$\log(1/c_{\pm})$	$\mu_{\pm}^{\frac{1}{2}}$
0.125	0.2014	0.4952	0.9895
.25	.2178	.4613	1.185
.5	.2430	.4137	1.493

B = NaCl; $T = 273.1^\circ\text{K}$ (204)

c_B	s_A	$\log(1/c_{\pm})$	$\mu_{\pm}^{\frac{1}{2}}$
0.1	0.00928	1.4971	0.330

B = NaNO₃; $T = 273.1^\circ\text{K}$ (204)

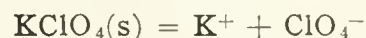
0.1	0.00972	1.4861	0.331
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B = TiClO₃; $T = 273.1, 288.1, 323.1, 373.1^\circ\text{K}$ (1166)B = KOH; $T = 287\text{--}288^\circ\text{K}$ (123); $T = 293.1^\circ\text{K}$ (201, 202)B = KOH + H₂O₂; $T = 298.1^\circ\text{K}$ (236)

$c(\text{KOH})$	$c(\text{H}_2\text{O}_2)$	s_A
0.0	0.0	0.675
.125	.0	.624
.250	.0	.573
.250	.015	.578
.250	.276	.584
.250	.954	.616
.250	1.073	.673
0.0	1.260	.730
0.0	1.310	.737

B = KCl; $T = 287\text{--}288^\circ\text{K}$ (123); $T = 293.1^\circ\text{K}$ (1533)B = KBr; $T = 287\text{--}288^\circ\text{K}$ (123)B = KI; $T = 287\text{--}288^\circ\text{K}$ (123)B = KNO₃

c_B	s_A	c_B	s_A
$T = 291.97^\circ\text{K}$ (26)			
0.0	0.645	0.5	0.515
$T = 292.95^\circ\text{K}$ (26); for $T = 287\text{--}288^\circ\text{K}$, v. (123)			
0.0	0.570	1.0	0.374
.125	.529	2.0	.328
.25	.492		

B = K₂SO₄; $T = 287\text{--}288^\circ\text{K}$ (123)B = K₂C₂O₄, Oxalate; $T = 287\text{--}288^\circ\text{K}$ (123)B = HClO₄; $T = 298.3^\circ\text{K}$ (1436)

m_B	S_A	$\log(1/m_{\pm})$	$\mu_{\pm}^{\frac{1}{2}}$
0.0	0.1505	0.8225	0.3875
.01	.1443	.8262	.3928
.1	.1072	.8267	.4552
1	.0381	.7014	1.019

B = C₂H₆O, Ethyl alcohol + HClO₄; $T = 298.3^\circ\text{K}$ (1436)

% C ₂ H ₆ O	% HClO ₄	A, Mol/1000 g soln.
93.5	0.2	0.0127
98.8	.2	.0007
98.8	2.0	.0020

B = BaCl₂; $T = 298.1^\circ\text{K}$ (162)

m_B	S_A	$\log(1/m_{\pm})$	$\mu_{\pm}^{\frac{1}{2}}$
0.0	0.1491	0.8265	0.386
.04955	.1569	.8054	.544
.1487	.1638	.786	.781
.2997	.1693	.7714	1.034

KClO₄—(Continued)
B = Ba(NO₃)₂; T = 298.1°K (162)

<i>m_B</i>	<i>S_A</i>	log (1/ <i>m_±</i>)	<i>μ</i> ^{1/2}
0.0495	0.1605	0.795	0.566
.1509	.1747	.758	.792
.3037	.1902	.721	1.049

B = NaCl; T = 298.1°K (162)

0.1007	0.1567	0.8049	0.5073
.2994	.1658	.7804	.682
.5903	.1732	.7615	.8738

B = NaClO₄; T = 298.1°K (162)

0.1026	0.1122	0.8090	0.4572
.309	.0752	.7696	.6198
.6273	.0533	.7203	.8251

B = NaNO₃; T = 298.1°K (162)

0.1008	0.1611	0.7929	0.5118
.3139	.179	.7472	.702
.622	.1994	.7003	.8675

B = Na₂SO₄; T = 298.1°K (162)

0.0528	0.1633	0.7870	0.5672
.1605	.180	.7447	.814
.3305	.1951	.7002	1.089

B = KCl; T = 298.1°K (162)

0.0983	0.1136	0.8093	0.4603
.2994	.0757	.7734	.6125
.6089	.0535	.7252	.8139

<i>c_B</i>	<i>s_A</i>	log (1/ <i>c_±</i>)	<i>μ_c</i> ^{1/2}
T = 298.1°K (1078)			
0.0	0.1481	0.8295	0.385
.04973	.1282	.8205	.4218
.09933	.1123	.8023	.460

B = KNO₃; T = 298.1°K (162)

<i>m_B</i>	<i>S_A</i>	log (1/ <i>m_±</i>)	<i>μ</i> ^{1/2}
0.0971	0.1173	0.7995	0.4631
.2954	.0846	.7464	.6164
.6686	.0642	.6637	.856

B = K₂SO₄; T = 298.1°K (162)

0.0499	0.1194	0.7909	0.5187
.1517	.0857	.7385	.7354
.3004	.0644	.6840	.9826

<i>c_B</i>	<i>s_A</i>	log (1/ <i>c_±</i>)	<i>μ_c</i> ^{1/2}
T = 298.1°K (1078)			
0.02485	0.1315	0.8115	0.454
.04961	.1181	.7954	.516

KBrO₃(s) = K⁺ + BrO₃⁻

B = NaCl; T = 298.1°K (468)

<i>c_B</i>	<i>s_A</i>	log (1/ <i>c_±</i>)	<i>μ_c</i> ^{1/2}
0.0	0.4715	0.3265	0.6859
.5	.5220	.2923	1.011
1	.5616	.2505	1.25
2	.6042	.2188	1.614
3	.6244	.2045	1.904
4	.6400	.1938	2.154

B = NaNO₃; T = 298.1°K (468)

0.5	0.5745	0.2407	1.037
1	.6794	.1678	1.296
2	.768	.1146	1.664
3	.9026	.0444	1.976
4	1.031	−0.01326	2.243

KIO₃(s) = K⁺ + IO₃⁻
B = KOH; T = 293.1°K (201)

<i>c_B</i>	<i>s_A</i>	<i>c_B</i>	<i>s_A</i>
4.71	0.0390	11.10	0.0128
5.06	.0362	12.19	.0131
6.35	.0256	12.92	.0135
7.95	.0179	14.02	.0154
9.41	.0144	14.85	.0194
10.95	.0130		

KMnO₄(s) = K⁺ + MnO₄⁻

B = Na₂SO₄; T = 298.1°K (1456)

<i>c_B</i>	<i>s_A</i>	<i>d₄</i> ²⁵
0.0	0.469	1.0454
.0655	.490	1.0554
.5535	.548	1.1180
1.691	.489	1.2363

B = KOH; T = 298.1°K (1456)

<i>c_B</i>	<i>s_A</i>	<i>c_B</i>	<i>s_A</i>
1.0	0.228	6.0	0.092
2.0	.153	8.0	.046
4.0	.102	10.0	.032

B = KCl; T = 298.1°K (1456)

0.1	0.4315	1.0	0.220
.5	.306	2.0	.1432

B = K₂SO₄; T = 298.1°K (1456)

<i>c_B</i>	<i>s_A</i>	<i>d₄</i> ²⁵
0.0	0.469	1.0454
.048	.437	1.0483
.1195	.395	1.0537
.337	.307	1.0730
.486	.266	1.0876
.583	.247	1.0979

B = K₂CO₃; T = 298.1°K (1456)

<i>c_B</i>	<i>s_A</i>	<i>c_B</i>	<i>s_A</i>
0.05	0.4375	2.0	0.093
.5	.2589		

2PbBr₂.KBr(s) = 2Pb⁺⁺ + K⁺ + 5Br⁻

B = KBr

<i>m_B</i>	<i>m</i> (PbBr ₂)	<i>m_B</i>	<i>m</i> (PbBr ₂)
T = 298.1°K (1192)			
0.3887	0.0070	0.8041	0.00740
.5902	.00707	1.200	.01137

<i>c_B</i>	<i>c</i> (PbBr ₂)	<i>c_B</i>	<i>c</i> (PbBr ₂)
T = 298.1°K (611)			
0.79	0.00725	3.23	0.08542
1.58	.00874	4.28	.1790
2.16	.02650		

PbBr₂ added to solution of concentration shown. Solid 2PbBr₂.KBr must have been present

K[Co(NO₂)₂C₂O₄(NH₃)₂](s) = K⁺ +

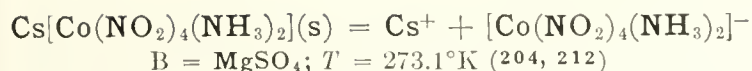
[Co(NO₂)₂C₂O₄(NH₃)₂]⁻

B = KCl; T = 273.1°K (204)

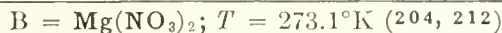
<i>c_B</i>	<i>s_A</i>	log (1/ <i>c_±</i>)	<i>μ_c</i> ^{1/2}
0.1	0.00351	1.7199	0.321

B = KNO₃; T = 273.1°K (204)

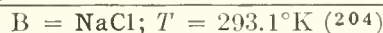
0.1	0.03800	1.7020	0.3215
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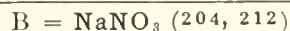
c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
0.0	0.00532	2.2741	0.0730
.5	.00815	2.1888	1.417



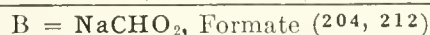
0.5	0.01113	1.9535	1.230
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0.0	0.01713	1.7664	0.1306
.1	.01987	1.7018	.3455



$T, ^\circ\text{K}$	c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
273.1	0.1	0.01268	1.8969	1.006
293.1	0.1	0.02055	1.6872	0.347



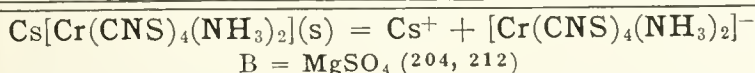
273.1	1.0	0.00785	2.1051	1.004
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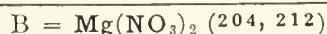
293.1	0.1	0.020210	1.6944	0.3464
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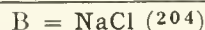
293.1	0.1	0.020920	1.6794	0.347
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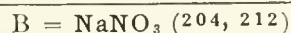
$T, ^\circ\text{K}$	c_B	s_A	$\log (1/c_{\pm})$	$\mu_c^{\frac{1}{2}}$
273.1	0.0	0.00789	3.1029	0.0289
273.1	.5	.00976	3.0105	1.414



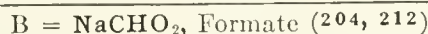
273.1	0.5	0.001356	2.8677	1.226
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293.1	0.0	0.002629	2.5802	0.0512
293.1	.1	.003072	2.5126	.320



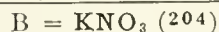
273.1	1.0	0.001365	2.8649	1.006
293.1	0.1	0.003182	2.4073	0.321



273.1	1.0	0.000831	3.0804	1.000
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293.1	0.1	0.003110	2.5072	0.321
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293.1	0.1	0.003233	2.4904	0.321
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LITERATURE

(For a key to the periodicals see end of volume)

- (1) Abbott and Bray, *1*, **31**: 729; 09. (2) Abegg, *9*, **13**: 440; 07. (3) Abegg and Auerbach, *Handbuch der anorganischen Chemie*, Leipzig, Hirzel, 1913. (4) Abegg and Cox, *7*, **46**: 1; 03. (5) Abegg and Pick, *25*, **38**: 2571; 05. (6) Abegg and Pick, *93*, **61**: 1; 06. (7) Abegg and Riesenfeld, *7*, **40**: 84; 02. (8) Abegg and Spencer, *93*, **44**: 379; 05. (9) Abegg and Spencer, *93*, **46**: 406; 05. (10) Abel, *B13*: p. 1. (10.5) Abich, *13*, **26**: 314; 1831. (11) Åkerlöf, *1*, **48**: 1160; 26. (12) Allen and Lombard, *12*, **43**: 175; 17. (13) Allmand, *4*, **97**: 603; 10. (14) Allmand and Hunter, *83*, **24**: 300; 28. (15) Allmand and Polack, *4*, **115**: 1020; 19. (16) Allner, *397*, **48**: 1035, 1057, 1081, 1107; 05. (17) Allner, *Diss.*, Karlsruhe, 1905. (18) Andreae, *7*, **7**: 241; 91. (19) Andrew, *4*, **106**: 444; 14. (20) Andrussov, *7*, **115**: 273; 25. (21) Andrussov, *7*, **116**: 81; 25. (22) Applebey and Reid, *4*, **121**: 2129; 22. (23) Aretowski, *93*, **8**: 314; 95. (24) Armstrong and Eyre, *5*, **88**: 234; 13. (25) Arndt and Schraube, *B13*: p. 46. (26) Arrhenius, *7*, **11**: 391; 93. (27) Askenasy and Klonowsky, *9*, **16**: 104; 10. (28) Askenasy and Solberg, *B13*: p. 53. (29) Atkins and Werner, *4*, **101**: 1167; 12. (30) Atkinson; cf. (1184). (31) Atkinson, Heycock and Pope, *4*, **117**: 1410; 20. (32) Auerbach, *93*, **37**: 353; 03. (33) Auerbach, *9*, **10**: 161; 04. (34)

- Auerbach, *7*, **49**: 217; 04. (35) Auerbach and Pick, *291*, **38**: 243; 11. (36) Auerbach and Pick, *291*, **46**: 113; 13. (37) Babinski, *Diss.*, Leipzig, 1906. See (196, 470). (38) Badger, *1*, **46**: 2166; 24. (39) Bäckstrom, *7*, **97**: 179; 21. (40) Bagdasarian, *78*, **51**: 449; 27. (41) Bagster, *4*, **111**: 494; 17. (42) Bahr, *93*, **71**: 79; 11. (43) Bahr and Sackur, *93*, **73**: 101; 11. (44) Baker, *4*, **66**: 615; 94. (45) Ballin, *Diss.*, Würzburg, 1923. See (1025). (46) Balz, *Thesis*, Darmstadt, 1919. (47) Barnes, *50*, **4**: 339; 00. (48) Barnes, *62*, **199**: 149; 02. (49) Barnes, *Rep. Brit. Assoc.*, Winnipeg, 403; 09. (50) Barnes and Lucas, *50*, **8**: 196; 04. (51) Barre, *34*, **150**: 1321; 10. (52) Barre, *34*, **160**: 1599; 10. (53) Barre, *6*, **24**: 145; 11. (54) Barre, *27*, **11**: 646; 12. (55) Barre, *34*, **166**: 1017; 13. (56) Bartlett, *1*, **49**: 65; 27. (57) Barus, *3*, **29**: 141; 90. (58) Bassarow, *42*, **1**: 283; 70. (59) Bassett and Taylor, *4*, **105**: 1926; 14. (60) Bates and Kirschman, *1*, **41**: 1991; 19. (61) Baubigny, *34*, **146**: 1263; 08. (62) Baud, *6*, **1**: 8; 04. (63) Baur and Glaessner, *7*, **43**: 354; 03. (64) Baur and Orthner, *7*, **91**: 75; 16. (65) Baur and Voerman, *7*, **62**: 467; 05. (66) Baxter and Cooper, *1*, **46**: 923; 24. (67) Baxter, Hickey and Holmes, *1*, **29**: 127; 07. (68) Baxter and Lansing, *1*, **42**: 419; 20. (69) Baxter and Starkweather, *1*, **38**: 2038; 16. (70) Baxter and Warren, *1*, **33**: 340; 11. (71) Beek, *9*, **17**: 843; 11. (72) Beek and Stegmüller, *291*, **34**: 446; 10. (73) Bell, *4*, **21**: 350; 68. (74) Bell and Taber, *50*, **11**: 637; 07. (75) Bellati and Lussana, *24*, **7**: 8; 89. (76) Bellati, Manfredo and Lussana, *24*, **7**: 1051; 89. (77) Benrath and Kohlberg, *93*, **138**: 65; 24. (78) Berger and Crut, *34*, **173**: 977; 21. (79) Bergius, *B13*: p. 68. (80) Bergmann, *397*, **39**: 117; 96. (81) Bergstrom, *50*, **26**: 358; 22. (82) Bergstrom, *1*, **46**: 1559; 24. (83) Berl and Austerweil, *9*, **13**: 165; 07. (84) Berl and Samtleben, *92*, **35**: 201, 206; 22. (85) Bernhardt, *63*, **26**: 265; 25. (86) Bernini, *63*, **7**: 168; 06. (87) Berthelot, *34*, **131**: 380; 00. (87.5) Berthelot, *B73*, **2**: 169; 97. (88) Biehowsky, *1*, **44**: 116; 22. (89) Biehowsky, *1*, **45**: 2225; 23. (90) Biltz, *7*, **19**: 385; 96. (91) Biltz, *7*, **40**: 185; 02. (92) Biltz, *7*, **43**: 41; 03. (93) Biltz, *7*, **82**: 688; 13. (94) Biltz, *93*, **130**: 93; 23. (95) Biltz and Fetkenheuer, *93*, **83**: 163; 13. (96) Biltz and Fetkenheuer, *93*, **89**: 97; 14. (97) Biltz and Fetkenheuer, *93*, **89**: 134; 14. (98) Biltz and Fischer, *93*, **124**: 230; 22. (99) Biltz and Fischer, *93*, **129**: 1; 23. (100) Biltz and Hansen, *93*, **127**: 1; 23. (101) Biltz and Hüttig, *93*, **109**: 89; 20. (102) Biltz and Hüttig, *93*, **109**: 111; 20. (103) Biltz and Hüttig, *93*, **114**: 241; 20. (103.5) Biltz and Hüttig, *93*, **119**: 115; 21. (104) Biltz and Messerknecht, *93*, **129**: 161; 23. (105) Biltz and Meyer, *7*, **4**: 262; 89. (106) Biltz and Meyer, *25*, **22**: 725; 89. (107) Biltz and Stollenwerk, *93*, **114**: 174; 20. (108) Biltz and Stollenwerk, *93*, **119**: 97; 21. (109) Bineau, *6*, **67**: 240; 38. (110) Birge and Sponer, *2*, **28**: 259; 26. (111) Birner and Kuhne, *42*, **12**: 432; 14. (112) Biron, *53*, **31**: 171; 99. (113) Bissell and James, *1*, **38**: 873; 16. (114) Bjerrum, *7*, **69**: 336, 581; 07. (115) Bjerrum, *7*, **73**: 724; 10. (116) Bjerrum, *7*, **79**: 513; 12. (117) Bjerrum, *7*, **81**: 281; 12. (118) Bjerrum, *7*, **79**, 537; 12. (119) Bjerrum, *214*, **12**: No. 4; 15. (120) Bjerrum, *93*, **119**: 179; 21. (121) Bjerrum, *7*, **106**: 230; 24. (122) Blanc, *42*, **18**: 28; 20. (123) Blarez, *34*, **112**: 434, 939, 1213; 11. (124) Blitz and Preuner, *7*, **39**: 323; 02. (125) Blum, *172 (Sth)*, **1**: 75; 12. (126) Bodenstein, *7*, **29**: 295; 99. (127) Bodenstein, *9*, **14**: 544; 08. (128) Bodenstein, *136*, **32**: 539; 08. (129) Bodenstein, *136*, **36**: 606; 13. (130) Bodenstein, *7*, **100**: 68; 21. (131) Bodenstein and Cramer, *9*, **22**: 327; 16. (132) Bodenstein and Dunant, *7*, **61**: 437; 07. (133) Bodenstein and Geiger, *7*, **49**: 70; 04. (134) Bodenstein and Katayama, *9*, **16**: 244; 09. (135) Bodenstein and Plant, *7*, **110**: 399; 24. (136) Bodenstein and Pöhl, *9*, **11**: 373; 05. (137) Bodenstein and Schubart, *9*, **23**: 105; 17. (138) Bodenstein and Suzuki, *9*, **16**: 912; 10. (139) Bodländer, *7*, **35**: 23; 00. (140) Bodländer and Eberlein, *25*, **36**: 3945; 03. (141) Bodländer and Fittig, *7*, **39**: 597; 01. (142) Bodländer and Storbeck, *93*, **31**: 1; 02. (143) Bodländer and Storbeck, *93*, **31**: 458; 02. (144) Bogue, *1*, **42**: 2575; 20. (145) Bohr and Boek, *8*, **44**: 318; 91. (146) Boissieu, *27*, **47**: 494; 87. (147) Bokhorst, *Diss.*, Amsterdam, 1915. (148) Bolte, *7*, **80**: 338; 12. (149) Bondnikoff and Syrkine, *Bull. Inst. Polytech. Ivanovo Voaniesensk.*, **7**: No. 1, 84; 23. (150) Bone and Coward, *4*, **97**: 1219; 10. (151) Bone and Jerdan, *4*, **71**: 41; 97. (152) Bone and Jerdan, *4*, **79**: 1042; 01. (153) Bonnefoi, *6*, **23**: 317; 01. (154) Bonnier, *14*, **6**: 37; 26. (155) Bonsdorff, *25*, **36**: 2322; 03. (156) Bonsdorff, *93*, **41**: 132; 04. (157) Born, *9*, **31**: 309; 25. (158) Bornemann and Hengatenberg, *187*, **17**: 339; 21. (159) Böttger, *7*, **46**: 521; 03. (160) Boudouard, *34*, **130**: 132; 00. (161) Bouton, Riddell and Duschak, *50*, No. **317**; 24. (162) Bozorth, *1*, **46**: 2653; 24. (163) Braithwaite, *135*, **72**: 211; 95. (164) Branch, *1*, **37**: 2316; 15. (165) Braun, *7*, **33**: 721; 00. (166) Braune, *93*, **111**: 109; 20. (168) Braune and Koref, *93*, **87**: 175; 14. (169) Braune and Ramstetter, *7*, **102**: 480; 22. (170) Brauner, *4*, **73**: 951; 98. (171) Bray, *1*, **32**: 932; 10. (172) Bray and Connolly, *1*, **33**: 1485; 11. (173) Bray and MacKay, *1*, **32**: 914; 10. (174) Bray and MacKay, *1*, **32**: 1207; 10. (175) Bray and Winninghoff, *1*, **33**: 1663; 11. (176) Bredig and Shirado, *9*, **33**: 209; 27. (177) Breitner,

- Thesis*, Budapest, 1911. (178) Bridgman, *1*, 36: 1344; 14. (179) Briggs and Migrdichian, *50*, 28: 1121; 24.
- (180) Brill, *93*, 45: 275; 05. (181) Brill, *8*, 21: 170; 06. (182) Briner, *42*, 4: 276; 06. (183) Briner, *42*, 13: 18; 15. (184) Briner, *34*, 162: 387; 16. (185) Briner and Kahn, *42*, 12: 534; 14. Kahn, *Thesis*, Geneva, 1914. (186) Brislee, *83*, 4: 159; 09. (187) Brönsted, *7*, 50: 481; 04. (188) Brönsted, *7*, 56: 645; 06. (189) Brönsted, *7*, 55: 371; 06.
- (190) Brönsted, *7*, 65: 84; 09. (191) Brönsted, *7*, 65: 744; 09. (192) Brönsted, *7*, 68: 693; 10. (193) Brönsted, *7*, 77: 129; 11. (194) Brönsted, *7*, 80: 206; 12. (195) Brönsted, *9*, 18: 714; 12. (196) Brönsted, *9*, 19: 754; 13. (197) Brönsted, *7*, 88: 479; 14. (198) Brönsted, *9*, 20: 81; 14. (199) Brönsted, *187*, 2: No. 10; 19.
- (200) Brönsted, *147*, 5: No. 25; 19. (201) Brönsted, *1*, 42: 1448; 20. (202) Brönsted, *1*, 42: 761; 20. (203) Brönsted, *4*, 119: 574; 21. (204) Brönsted, *1*, 44: 877; 22. (205) Brönsted, *1*, 44: 938; 22. (206) Brönsted, *7*, 100: 139; 22. (207) Brönsted, *1*, 45: 2898; 23. (208) Brönsted and Brumbaugh, *1*, 48: 2015; 26. (209) Brönsted and La Mer, *1*, 46: 555; 24.
- (210) Brönsted and Pedersen, *7*, 103: 307; 22. (211) Brönsted and Pedersen, *187*, 1: No. 3; 17. (212) Brönsted and Petersen, *1*, 43: 2265; 21. (213) Browne and Houlehan, *1*, 35: 649; 13. (214) Brühl, *25*, 28: 2847; 95. (215) Bruner, *9*, 19: 861; 13. (216) Bubnoff, *7*, 88: 641; 14. (217) Budde, *93*, 78: 169; 12. (218) Buchrer, *Unpubl. Thesis*, Univ. of Calif., Berkeley, Calif., 1921. (219) Buchrer and Roseveare, *1*, 49: 1989; 27.
- (220) Buchrer, Wartman and Nugent, *1*, 49: 1271; 27. (221) Bugarszky, *7*, 71: 705; 10. (222) Bunsen, *8*, 141: 1; 70. (223) Burdick and Freed, *1*, 43: 518; 21. (224) *365*, No. 29; 10. (225) *365*, No. 35; 19. (226) Burgstaller, *Abh. Lotos*, 3: 83; 12. (227) Burrell and Robertson, *1*, 37: 2482; 15. (228) Burrows, *1*, 46: 1623; 24. (229) Burrows and Fawsitt, *4*, 105: 609; 14.
- (230) Burrows and Lucarini, *1*, 49: 1157; 27. (231) Butler and Hiscocks, *4*, 1926: 2554. (232) Cahours, *13*, 141: 39; 67. (233) Cailletet and Bordet, *34*, 95: 58; 82. (234) Cailletet, Colardeau and Rivière, *34*, 130: 1585; 00. (235) Callender and Barnes, *5*, 62: 117; 97. (236) Calvert, *7*, 38: 513; 01. (237) Cameron, *50*, 5: 556; 01. (238) Cameron, *50*, 11: 641; 07. (239) Cameron and Bell, *50*, 10: 210; 06.
- (240) Cameron and Bell, *1*, 28: 1220; 06. (241) Cameron, Bell and Robinson, *50*, 11: 396; 07. (242) Cameron and Breazeale, *50*, 8: 335; 04. (243) Cameron and Brown, *50*, 9: 210; 05. (243.5) Cameron and Patten, *50*, 15: 67; 11. (244) Cameron and Robinson, *50*, 11: 577, 690; 07. (245) Cameron and Robinson, *50*, 11: 273; 07. (246) Cameron and Seidell, *50*, 6: 643; 01. (247) Cameron and Seidell, *50*, 7: 578, 588; 03. (249) Campbell, *Diss.*, Breslau, 1906. *See* (2).
- (250) Campbell, *135*, 96: 15, 25; 07. (251) Campbell, *83*, 3: 24; 07. (252) Cantelo, *50*, 28: 1036; 24. (253) Cantoni and Jolkowski, *27*, 1: 1181; 07. (254) Cantoni and Mauri, *27*, 3: 929; 08. (255) Carbonelli, *36*, 49 I: 151; 19. (256) Carmody, Stanford University, Calif., and Reed College, Portland, Oregon, *0*. (257) Carpenter and Jette, *1*, 45: 578; 23. (258) Carpenter and Smith, *140*, 98: 139; 18. (259) Carson, *1*, 29: 499; 09.
- (260) Carter, *4*, 127: 2861; 25. (261) Carter, Lea and Robinson, *4*, 131: 1906; 27. (262) Casselmann, *13*, 83: 257; 52. (263) Cavazzi, *36*, 46 II: 122; 16. (264) Caven and Ferguson, *4*, 121: 1406; 22. (265) Caven and Ferguson, *4*, 125: 1307; 24. (266) Caven and Sand, *4*, 99: 1359; 11. (267) Caven and Sand, *4*, 105: 2752; 14. (268) Centnerszwer, *7*, 85: 99; 13. (269) Centnerszwer and Andrusow, *7*, 111: 79; 24.
- (270) Centnerszwer and Bružs, *7*, 114: 237; 25. (271) Centnerszwer and Bružs, *7*, 115: 365; 25. (272) Centnerszwer and Bružs, *Acta Univ. Latviensis*, 14: 485; 26. (273) Centnerszwer and Bružs, *Ibid.*, 14: 505; 26. (274) Centnerszwer, Falk and Awerbach, *7*, 115: 29; 25. (275) Centnerszwer and Krustinsons, *7*, 132: 185; 28. (276) Chaudron, *34*, 159: 237; 14. (277) Chaudron, *14*, 16: 221; 21. (278) Chauvenet, *6*, 23: 275; 11. (279) Ming Chow, *1*, 42: 488; 20.
- (280) Christiansen, *7*, 103: 99; 23. (281) Claude, *34*, 169: 1039; 19. (282) Claus, *13*, 59: 234; 46. (283) Clement, *29*, No. 17: 11. (284) Clement and Adams, *29*, No. 7; 09. (285) Cleve, *93*, 32: 129; 02. (286) Clouet, *14*, 11: 30; 1791. (287) Coehn and Stuckardt, *7*, 91: 722; 16. (288) Cofetti and Forester, *25*, 38: 2934; 05. (289) Cohen, *7*, 18: 61; 95.
- (290) Cohen, *7*, 30: 623; 99. (291) Cohen, *7*, 33: 57; 00. (292) Cohen, *7*, 35: 588; 00. (293) Cohen, *7*, 36: 517; 01. (294) Cohen, *7*, 48: 243; 04. (295) Cohen, *18*, 5: 195; 00. (297) Cohen, Chattaway and Tombrook, *7*, 60: 706; 07. (298) Cohen and von Eyk, *7*, 30: 601; 99. (299) Cohen, Inouye and Euwen, *7*, 75: 1; 10.
- (300) Cohen and Moesveld, *7*, 115: 151; 25. (301) Colani, *34*, 156: 1075; 13. (302) Collenberg, *7*, 109: 353; 24. (303) Collins and Wood, *4*, 121: 441; 22. (304) Colson, *34*, 128: 1458; 99. (305) Colson, *34*, 132: 467; 01. (306) Colson, *34*, 140: 865; 05. (307) Colson, *34*, 148: 837; 09. (308) Colson, *34*, 154: 428; 12. (309) Condon, *197*, 13: 466; 27.
- (310) Coward and Wilson, *4*, 115: 1380; 19. (311) Cragoe, Meyers and Taylor, *1*, 42: 206; 20. (312) Creighton and Githens, *143*, 179: 161; 15. (313) Creighton and Ward, *1*, 37: 2333; 15. (314) Crut, *Thesis*, Paris, 1923. (315) Cundall, *4*, 59: 1076; 91. (316) Cundall, *4*, 67: 794; 95. (317) Dalton, Pomeroy and Weymouth, *1*, 46: 60; 24. (318) d'Anselme, *27*, 29: 936; 03. (319) Danneel, *7*, 33: 415; 00.
- (320) Davies, *5*, 78: 41; 06. (321) Davis, *4*, 95: 1397; 09. (322) Dawson and Leslie, *4*, 99: 1601; 11. (322.5) Day and White, Geophysical Laboratory, Washington, D. C., *0*. (323) Debray and Joly, *34*, 106: 100; 88. (324) Debray and Joly, *34*, 106: 328; 88. (325) Deckert, *Diss.*, Rostock, 1924. (326) Demassieux, *14*, 20: 233; 23. (327) Demassieux, *34*, 177: 51; 23. (328) Denham, *4*, 93: 41; 08. (329) Denham, *7*, 72: 641; 10.
- (330) Derby, Daniels and Gutsche, *1*, 36: 793; 14. (331) Derby and Yngve, *1*, 38: 1439; 16. (332) Deville, *34*, 70: 1105, 1201; 70. (333) Deville, *34*, 71: 30; 71. (334) DeVries and Rodebush, *1*, 49: 656; 27. (335) Dewar, *5*, 89: 158; 13. (336) de Wijs, *Thesis*, Delft, 1923. (337) Dhar and Datta, *9*, 19: 407; 13. (338) Ditte, *Thesis*, Paris, 1870. (339) Ditte, *25*, 9: 1130; 1432; 76.
- (340) Ditte, *34*, 83: 56, 223; 76. (341) Ditte, *34*, 92: 718; 81. (342) Ditz and Kanhäuser, *93*, 98: 128; 16. (343) Dixon, Campbell and Parker, *5*, 100: 1; 21. (344) Dixon and Greenwood, *5*, 105: 199; 24. (344.5) Dobler, *7*, 101: 1; 22. (345) Dodd, *1*, 42: 1579; 20. (346) Doerinkel and Werner, *93*, 115: 1; 20. (347) Dolezalek, *9*, 4: 349; 98. (348) Domke and Bein, *93*, 43: 125; 04. (349) Donnan and Thomas, *4*, 99: 1788; 11.
- (350) Doolan and Partington, *83*, 20: 342; 24. (351) Dougherty and Taylor, *50*, 27: 533; 23. (352) Dover, *Diss.*, Breslau, 1908. (353) Dragert, *Diss.*, Berlin, 1914. (354) Drucker, *93*, 28: 361; 01. (355) Drucker, *7*, 49: 563; 04. (356) Drucker, *9*, 17: 398; 11. (357) Dunn, *135*, 43: 121; 81. (358) Dunn, *135*, 45: 270; 82. (359) Dunningham, *4*, 105: 368; 14.
- (360) Eastman, *1*, 44: 975; 22. (361) Eastman and Evans, *1*, 46: 888; 24. (362) Eastman and Robinson, *1*, 50: 1106; 28. (363) Eastman and Rodebush, *1*, 40: 489; 18. (364) Eastman and Sullivan, U. S. Bureau of Mines Experiment Station, Berkeley, Calif., *0*. (365) Eastman, Williams and Young, *1*, 46: 1184; 24. (366) Edgar, *Thesis*, Mass. Inst. Tech., Boston, 1912. (367) Edgar and Cannon, *1*, 44: 2842; 22. (368) Egerton, *3*, 33: 33; 17. (369) Egerton, *5*, 103: 469; 23.
- (370) Ehrenberg and Bahr, *J. Landwirtschaft*, 61: 427; 23. (371) Ehlert and Hempel, *9*, 18: 727; 12. (372) Ellis, *1*, 38: 737; 16. (373) Emich, *57*, 26: 1011; 05. (373.5) von Ende, *93*, 26: 129; 01. (374) Engel, *6*, 13: 344; 88. (375) Engel, *6*, 17: 338; 89. (376) Engel and Ville, *34*, 93: 340; 81. (377) Engels, *397*, 62: 477, 493; 19. (377.5) Enklaar, *176*, 9: 28; 12. (378) Ephraim, *25*, 45: 1322; 12. (379) Ephraim, *7*, 81: 513; 13.
- (380) Ephraim, *7*, 83: 196; 13. (381) Ephraim, *25*, 46: 3103; 13. (382) Ephraim, *25*, 50: 1069; 17. (383) Ephraim, *25*, 51: 644; 18. (384) Ephraim, *25*, 51: 706; 18. (385) Ephraim, *25*, 52: 236; 19. (386) Ephraim, *25*, 52: 241; 19. (387) Ephraim, *25*, 52: 940; 19. (388) Ephraim, *25*, 52: 957; 19. (389) Ephraim and Aellig, *37*, 6: 37; 23.
- (390) Ephraim and Bolle, *25*, 48: 638; 15. 48: 1770; 15. (391) Ephraim and Jahnsen, *25*, 48: 41; 15. (392) Ephraim and Kornblum, *25*, 49: 2007; 16. (393) Ephraim and Linn, *25*, 46: 3742; 13. (394) Ephraim and Michel, *37*, 4: 900; 21. (395) Ephraim and Millmann, *25*, 50: 529; 17. (396) Ephraim and Moser, *25*, 53: 548; 20. (397) Ephraim and Muller, *25*, 54: 973; 21. (398) Ephraim and Rosenberg, *25*, 51: 130; 18. (399) Ephraim and Wagner, *25*, 50: 1088; 17.
- (400) Eucken, *7*, 107: 436; 23. (401) Eucken and Fried, *96*, 29: 36; 24. (402) Eucken and Karwat, *7*, 112: 467; 24. (403) Eucken, Karwat and Fried, *96*, 29: 1; 24. (403.5) von Euler, *25*, 36: 2878, 3400; 03. (404) Ewald, *8*, 44: 1213; 14. (405) Falcke, *25*, 46: 743; 13. (406) Falcke, *9*, 21: 37; 15. (407) Falcke, *9*, 22: 121; 16. (408) Falcke, *9*, 27: 268; 21. (408.1) von Falkenstein, *7*, 59: 313; 07. (408.2) von Falkenstein, *7*, 68: 270; 09. (408.3) von Falkenstein, *7*, 65: 371; 09. (409) Faurholt, *214*, 20: No. 3; 21.
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- (420) Findlay, *7*, 34: 409; 00. (421) Findlay, *4*, 85: 403; 04. (422) Findlay and Shen, *4*, 101: 1459; 12. (423) Finkelstein, *25*, 39: 1585; 06. (424) Fischer, *93*, 78: 41; 12. (425) Fischer and Braehmer, *25*, 39: 940; 06. (426) Fixed Nitrogen Research Laboratory, Washington, *Report on Fixation and Utilization of Nitrogen*, p. 218; 1922. (427) Folger and Rodebush, *1*, 45: 2080; 23. (428) Fonda and Van Aernem, *45*, 14: 539; 22. (429) Foote, *7*, 33: 740; 00.
- (430) Foote and Scholes, *1*, 33: 1309; 11. (431) Foote and Smith, *1*, 30: 1344; 08. (432) Forbes, *1*, 33: 1937; 11. (433) Forbes and Cole, *1*, 43: 2492; 21. (434) de Forcerand, *34*, 94: 967; 82. (435) de Forcerand, *34*, 130: 1308, 1388; 00. (436) de Forcerand, *34*, 176: 355; 23. (437) de Forcerand and Fonzes-Diacon, *6*, 26: 247; 02. (438) de Forcerand and Fonzes-Diacon, *34*, 134: 229; 02. (439) de Forcerand and Taboury, *34*, 169: 162; 19.
- (440) de Forcerand and Villard, *34*, 106: 849, 1357; 88. (441) Formanek, *185*, 18: 270; 87. (442) Fowler, *4*, 79: 285; 01. (443) Fox, *4*, 95: 878; 09. (444) Fraenkel, *9*, 19: 362; 13. (445) Franklin and Kraus, *50*, 11: 553; 07. (446) Fraps, *11*, 27: 288; 01. (447) Frary and Nietz, *1*, 37: 2268; 15. (448) Free, *1*, 30: 1366; 08. (449) Freeman, *324*, 6: 129; 22. (449.5) Fricke, *7*, 113: 248; 24.
- (450) Fried, *7*, 123: 406; 26. (451) Friedheim and Brühl, *91*, 38: 690; 99. (452) Friedrich, *192*, 4: 479; 07. (453) Friedrich, *77*, 31: 1909; 11. (454)

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- (470) Gerke, 1, 44: 1684; 22. (471) Gerke, 286, 1: 377; 25. (472) Gerke and Geddes, 50, 31: 886; 27. (473) Gerke and Gordon, 0; see (471). (474) Gerke and Rourke, 1, 49: 1855; 27. (475) Germs, 176, 14: 1156; 17. (476) Gerth, 9, 27: 287; 21. (477) Getman, 1, 38: 792; 16. (478) Getman, 1, 40: 611; 18. (479) Getman, 50, 32: 91; 28.
- (480) Getman, 50, 32: 940; 28. (481) Giacomini, 3, 50: 146; 25. (481.5) Giauque and Johnston, Univ. of Calif., Berkeley, Calif., 0. (482) Gibson, *Diss.*, Breslau, 1911. (483) Gibson and Heitler, 96, 49: 465; 28. (484) Gibson, Latimer and Parks, 1, 42: 1533; 20. (485) Gibson, Latimer and Parks, 1, 42: 1542; 20. (486) Gillespie, 197, 11: 73; 25. (487) Gillespie, 285, 4: 84; 25. (488) Gillespie, 1, 48: 28; 26. (489) Gillespie and Hall, 1, 48: 1207; 26.
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- (530) Gunther, 9, 23: 197; 17. (531) Guntz, 34, 128: 996; 99. (532) Gutbier, Leuehs, Wiessmann and Maisch, 93, 96: 182; 16. (533) Gutbier and Ransohoff, 93, 45: 243; 05. (534) Gutmann, 13, 299: 267; 98. (535) Haber, 7, 68: 726; 09. (536) Haber, 9, 16: 244; 10. (537) Haber, 9, 20: 597; 14. (538) Haber, 92, 27: 475; 14. (539) Haber, Tamaru and Ponnaz, 9, 21: 89; 15.
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- (550) Haber and Koenig, 9, 13: 725; 07. (551) Haber and Koenig, 9, 14: 689; 08. (552) Haber and Le Rossignol, 25, 40: 2144; 07. (553) Haber and Le Rossignol, 9, 14: 181; 08. (554) Haber and Le Rossignol, 9, 14: 513, 688; 08. (555) Haber and Moser, 9, 11: 593; 05. (556) Haber and van Oordt, 93, 43: 111; 05. (557) Haber and van Oordt, 93, 44: 341; 05. (558) Haber and van Oordt, 93, 47: 42; 05. (559) Haber and Riehardt, 93, 38: 5; 04.
- (560) Haber and Zisch, 96, 9: 302; 22. (561) Haekspill, 34, 154: 877; 12. (562) Haekspill, 6, 27: 613; 13. (563) Haehnle, 52, 107: 165; 24. (564) Haehnle, 52, 108: 187; 24. (565) Haehnle, 52, 108: 61; 24. (566) Hahn, 7, 44: 513; 03. (567) Hahn, 7, 48: 735; 04. (568) Halla, 9, 30: 124; 24. (569) Hampton, 50, 30: 980; 26.
- (570) Harkins, 1, 33: 1807; 11. (571) Harkins and Paine, 1, 41: 1155; 19. (572) Harkins and Pearce, 1, 38: 2679; 16. (573) Harkins and Winninghoff, 1, 33: 1827; 11. (574) Harman, 50, 31: 616; 27. (575) Harman and Worley, 83, 20: 502; 25. (576) Harned, 1, 37: 2460; 15. (577) Harned, 1, 38: 1986; 16. (578) Harned, 1, 42: 1808; 20. (579) Harned, 1, 48: 326; 26.
- (580) Harned and Åkerlöf, 63, 27: 411; 26. (581) Harned and Brumbaugh, 1, 44: 2729; 22. (582) Harned and Fleysher, 1, 47: 82; 25. (583) Harned and Sturgis, 1, 47: 945; 25. (584) Harned and Swindells, 1, 48: 126; 26. (585) Harries, 397, 37: 82; 94. (586) Hartek, 7, 134: 1; 28. (587) Hartley and Campbell, 4, 93: 741; 08. (588) Haslam, 45, 16: 782; 24. (589) Haslam, Calingaert and Taylor, 1, 46: 308; 24.
- (590) Haslam and Forrest, *Gas Age-Record*, 52: 615; 23. (591) Hauser and Wirth, 91, 47: 389; 08. (592) Hauser and Wirth, 92, 22: 484; 09. (593) Hauser and Wirth, 52, 79: 358; 09. (594) Hauser and Wirth, 93, 78: 75; 12. (595) Hedvall, 93, 98: 47; 16. (596) Heike, 93, 118: 254; 21. (597) Hellwig, 93, 25: 157; 00. (597.5) Hempel and Schubert, 9, 18: 729; 12. Hempel, *Diss.*, Dresden, 1912. (598) Henderson and Stegeman, 1, 40: 84; 18. (599) Henderson and Taylor, 50, 20: 663; 16.
- (600) Henglein, 96, 12: 245; 22. (601) Henglein, 93, 123: 137; 22. (602) Henglein and Krüger, 93, 130: 181; 23. (603) Henglein, Rosenberg and Muchlinski, 96, 11: 1; 22. (604) Henning, 8, 43: 282; 14. (605) Herz, 18, 2: 193; 12. (606) Herz, 93, 94: 1; 16. (607) Herz, 93, 30: 280; 02. (608) Herz, 93, 66: 358; 10. (609) Herz, 93, 71: 206; 11.
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- (630) Hill and Simmons, 1, 31: 821; 09. (631) Hiller, 7, 81: 591; 13. (632) Hilpert and Diekmann, 25, 48: 1281; 15. (633) Hirsch, *Thesis*, Budapest. (634) Hirschkind, 93, 67: 113; 10. (634.5) van't Hoff, *Ala wrong*, Hinrichsen, Weigert and Just, 7, 45: 257; 08. (635) Hoffman and Langebeek, 7, 51: 385; 05. (636) Hofman and Wanjukow, 80, 43: 523; 12. (637) Hogness and Lunn, 2, 27: 642; 26. (638) Hogness and Lunn, 2, 27: 732; 26. (639) Hoitsema, 7, 17: 1; 95.
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- (650) Horstmann, 25, 9: 749; 76. (651) Horstmann, 13, 187: 48; 77. (652) Hüttig, 93, 114: 161; 20. (653) Hüttig, 93, 123: 31; 22. (654) Hüttig, 93, 124: 322; 22. (655) Hüttig and Kurre, 93, 122: 44; 22. (655.5) Hüttig and Kurre, 93, 126: 167; 23. (656) Hüttig and Martin, 93, 125: 269; 22. (657) Hüttig and Pohle, 93, 138: 1; 24. (658) Hüttig and Reuseher, 93, 137: 155; 24. (659) Hüttig and von Schroder, 93, 121: 243; 22.
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- (670) Isambert, 34, 92: 919; 81. (671) Isambert, 34, 93: 731; 81. (672) Isambert, 34, 96: 340; 82. (673) Isambert, 34, 97: 1212; 83. (674) Ishikawa and Shibata, 41, 48: 59; 27. (675) Isnardi, 8, 61: 264; 20. (675.5) van Iterson-Rotgans, 7, 87: 305; 14. (676) Jackson, 4, 99: 1066; 11. (677) Jacques, 83, 5: 225; 08. (678) Jacob, *Diss.*, Breslau, 1924. (678.5) Jacobs, 176, 14: 208; 17. (679) Jaeger, 93, 27: 22; 01.
- (680) Jaeger, *Die Normalelemente*. Halle, Knapp, 1902. (681) Jaeger, 8, 14: 726; 04. (682) Jaeger and Kahle, 243, 18: 161; 98. (683) Jaeger and Kahle, 8, 65: 926; 98. (684) Jaeger and Lindeek, 243, 21: 33, 65; 01. (685) Jaeger and Lindeek, 8, 5: 1; 01. (686) Jaeger and Lindeek, 7, 37: 641; 01. (687) Jaeger and Wachsmuth, 101, 15: 507; 94. (688) Jaeger and Wachsmuth, 8, 59: 575; 96. (689) Jahn, 93, 60: 292; 08.
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- (720) Johnston, 1, 38: 947; 16. (721) Johnston, 45, 9: 873; 17. (722) Jolibois, *Thesis*, Paris, 1910. (723) Jolibois, 34, 149: 287; 09. (724) Jolibois, 34, 151: 382; 10. (725) Jones, 4, 99: 392; 11. (726) Jones, 4, 105: 2310; 14. (727) Jones and Hartmann, 1, 37: 752; 15. (728) Jones and Hartmann, 1, 37: 241; 15. (729) Jones and Hartmann, 78, 30: 295; 16.
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- (750) Kasarnowsky, 7, 109, 287; 24. (751) Katz, 202, 95: 16; 15. (752) Kendall, 3, 23: 958; 12. (753) Kendall, 147, 2: No. 38; 13. (754) Kendall, 1, 38: 1480; 16. (754.5) Kendall and Andrew, 1, 43: 1545; 21. (755) Kendall and Fuchs, 1, 43: 2017; 21. (756) Kendall and Fuchs, 1, 44: 1447; 22. (757) Kernot, d'Agostino and Pellegrino, 36, 38 I: 532; 08. (758) Kernot and Pomilio, 71, 17: 353; 12. (759) Keyes, 1, 34: 779; 12.
- (760) Keyes and Brownlee, 1, 40: 25; 18. (760.5) Keyes and Brownlee, *Thermodynamic properties of ammonia*. John Wiley and Sons, New York, 1916. (761) Keyes and Felsing, 1, 42: 246; 20. (762) Keyes and Hara, 1, 44: 479; 22. (763) Klein, 93, 74: 157; 12. (764) Klemene and Herzog, 57, 47: 405; 27. (765) Klinkhardt, 8, 84: 167; 27. (766) Knietsch, 13, 259: 100; 90. (767) Knopp, 7, 48: 97; 04. (768) Knox, 83, 4: 29; 08. (769) Knox and Will, 4, 115: 853; 19.
- (770) Knudsen, 8, 29: 179; 09. (771) Knudsen, 8, 32: 809; 10. (772) Knüpfner, 7, 26: 255; 98. (773) Kohlrausch, 7, 12: 773; 93. (774) Kohlrausch, 7, 64: 129; 08. (776) Kohlschütter and Eydmann, 13, 398: 1; 13. (777) Kohner, *Diss.*, Berlin, 1914. (778) Kolthoff, 93, 109: 69; 19. (779) Kolthoff, 176, 16: 1134; 19.
- (780) Kolthoff, 70, 42: 973; 23. (781) Kolthoff, 70, 42: 969; 23. (782) Kolthoff, *Gebrauch der Farbenindikatoren*. Berlin, Springer, 1923. (783) Kolthoff, 70, 43: 207; 24. (784) Kolthoff, 70, 43: 216; 24. (785) Kopp, 13, Suppl. 3: 289; 65. (786) Kopp, 62, 155: 71; 65. (787) Koppel, 93, 67: 293; 10. (788) Koppel and Holtkamp, 93, 67: 266; 10. (789) Koref, 93, 66: 73; 10. (789.5) Koref and Braune, 9, 18: 818; 12.
- (790) Koster, *see* (852). (791) Kovách, 7, 80: 107; 12. (792) Krahmer, 9, 26: 97; 20. (793) Kraus, 1, 30: 653; 01. (794) Kraus and Hurd, 1, 45: 2559; 23. (795) Kraus and Gerlach, 93, 140: 61; 24. (795.5) Kremann and Rodemund, 57, 35: 1061; 14. (796) Kremann, Zoft, and Ostwald, 57, 43: 139; 22. (797) Kremers, 8, 85: 246; 52. (798) Kröner, 8, 40: 438; 13. (799) Kruyt, 7, 64: 513; 08.
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- (810) Lamb and Fairhall, 1, 45: 378; 23. (811) Lamb and Fonda, 1, 43: 1154; 21. (812) Lamb and Larson, 1, 42: 2024; 20. (813) Lambert and Gates, 5, 108: 456; 25. (814) LaMer, King and Mason, 1, 49: 363; 27. (815) LaMer and Mason, 1, 49: 410; 27. (816) Lampen, 1, 28: 846; 06. (817) Lane, 34, 124: 819; 97. (818) Landis, 33, 22: 265; 20. (818.5) Lang, 397, 1888: 933. (819) Lang and Rigaut, 34, 129: 294; 99.
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- (930) Mackae, *Thesis*, Mass. Inst. Tech., Boston, 1917. (931) Mackay and Ferguson, 143, 181: 209; 16. (932) MacRae and Voorhis, 1, 43: 547; 21. (933) Maeda, 469, 2: 350; 23. (934) Magnus, 63, 14: 5; 13. (935) Magnusson, 50, 11: 21; 07. (936) Maier, 1, 48: 356; 26. (937) Maier, Bureau of Mines, Berkeley, Calif., 0. (938) Maier, Parks and Anderson, 1, 48: 2564; 26. (939) Maier and Ralston, 1, 48: 364; 26.
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- (990) Meyer, 93, 81: 385; 13. (991) Meyer, 93, 86: 257; 14. (991.5) von Meyer, 52, 36: 292; 87. (992) Meyer and Jannek, 91, 52: 534; 13. (994) Meyer and Orthner, 25, 54B: 1705; 21. (995) Meyer and Rötgers, 93, 57: 104; 08. (996) Meyer and Winter, 93, 67: 398; 10. (996.5) Meyerhoffer, 7, 53: 513; 05. (997) Michaelis and Mizutani, 7, 116: 135; 25. (998) Milbauer, 136, 33: 513; 09. (999) Milbauer, 136, 33: 522; 09.
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- (1070) Nippert, Diss., Breslau, 1913. (1071) Nishizawa, 142, 23: 830; 20. (1072) Nonhebel, 3, 2: 1085; 26. (1073) Nordmeyer, 26, 10: 202; 08. (1074) Növcacs, Thesis, Budapest, 1910. See (791). (1075) Noyes, 7, 6: 241; 90. (1076) Noyes, 7, 9: 603; 92. (1077) Noyes and Abbott, 7, 16: 125; 95. (1078) Noyes and Boggs, 1, 33: 1650; 11. (1079) Noyes and Brann, 1, 34: 1016; 12.
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- (1100) Oliveri-Mandala, 36, 45 I: 303; 15. (1100.5) Olson, 1, 42: 896; 20. (1101) Orthner, Thesis, Zürich, 1915. (1101.5) Osborne and Van Dusen, see (760.5). (1102) Ostwald, 7, 3: 170; 89. (1103) Ostwald, *Lehrbuch der allgemeinen Chemie*, Leipzig, 1893. (1104) Ostwald and Heucke, 50, 29: 49; 84. (1105) Padoa and Tibaldi, 22, 12 II: 158; 03. (1106) Palmacer, 9, 29: 415; 23. (1107) Pareau, 13, 1: 39; 87. (1108) Parks and Kelley, 50, 30: 47; 26. (1109) Parravano and Malquori, 36, 56: 3; 26.
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- (1260) Ross, 4, 105: 690; 14. (1261) van Rossem, 176, 9: 657; 12. (1262) Roth, 7, 63: 441; 08. (1263) Roth, 9, 26: 288; 20. (1264) Roth and Wallasch, 25, 46: 896; 13. (1265) Rothmund, 7, 33: 401; 00. (1266) Rothmund, 93, 31: 136; 02. (1267) Rothmund, 7, 69: 523; 10. (1268) Rothmund and Drucker, 7, 46: 827; 03. (1268.5) van Royen, Diss., Bonn, 1911. See (852). (1269) Rubenbauer, 93, 30: 331; 02.
- (1270) Ruby, 1, 43: 294; 21. (1271) Rudolfi, 93, 54: 170; 07. (1272) Ruer.

- 93, 50: 265; 06. (1273) Ruer and Nakamoto, 70, 42: 675; 23. (1274) Ruff and Bergdahl, 93, 106: 76; 19. (1275) Ruff and Bormann, 93, 88: 307; 14. (1276) Ruff and Graff, 93, 58: 209; 08. (1277) Ruff and Hartmann, 93, 133: 29; 24. (1278) Ruff and Keilig, 93, 88: 410; 14. (1279) Ruff and Schmidt, 93, 117: 172; 21.
- (1280) Russ, 7, 82: 217; 13. (1281) Russell, 63, 13: 59; 12. (1282) Sabatier, 34, 158: 668; 14. (1283) Sackur, 291, 20: 512; 03. (1284) Sackur, 9, 10: 522; 04. (1285) Sackur and Taegener, 9, 18: 718; 12. (1286) Sainte-Claire Deville and Troost, 34, 49: 239; 59. (1287) Sainte-Claire Deville and Troost, 6, 58: 257; 60. (1288) Sainte-Claire Deville and Troost, 34, 56: 895; 63. (1289) Sainte-Claire Deville and Troost, 34, 91: 83; 80.
- (1290) Salvadori, 36, 42 I: 458; 12. (1291) Sammet, 7, 53: 641; 05. (1292) Sand, 7, 48: 610; 04. (1293) Sandonnini, 22, 21 II: 524; 12. (1294) Saposchnikov, 53, 32: 375; 00. (1295) Saposchnikov, 7, 49: 697; 03. (1296) Saposchnikov, 7, 51: 609; 05. (1297) Saposchnikov, 7, 53: 225; 05. (1298) Saunders, 50, 28: 1151; 24. (1299) Scatchard, 1, 47: 641; 25.
- (1300) Scatchard, 1, 47: 2098; 25. (1301) Scheel and Heuse, 8, 31: 715; 10. (1302) Scheffer, 64P, 18: 446; 15. (1303) Scheffer, 64P, 18: 1498; 16. (1304) Scheffer, 64P, 19: 798; 17. (1305) Scheffer and Meyer, 64P, 21: 1338; 19. (1306) Scheffer and Treub, 7, 81: 308; 13. (1307) Schenck, 9, 24: 248; 18. (1308) Schenck and Albers, 93, 105: 145; 18. (1309) Schenck and Heller, 25, 38: 2132, 2139; 05.
- (1310) Schenck and Hempelmann, 187, 10: 283; 13. (1311) Schenck and Rassbach, 192, 4: 455; 07. (1312) Schenck and Rassbach, 25, 40: 2185; 07. (1313) Schenck and Rassbach, 25, 40: 2947; 07. (1314) Schenck and Rassbach, 25, 41: 2917; 08. (1315) Schenck, Semiller and Faleke, 25, 40: 1704; 07. (1316) Schierholz, 75, 101 IIb: 4; 90. (1317) Schildbach, 9, 16: 967; 10. (1318) Schlesinger, Mullinix and Popoff, 45, 11: 317; 19. (1319) Schloesing, 34, 74: 1552; 72. 75: 70; 72. Values corrected by (719).
- (1320) Schmidt, *Diss.*, Berlin, 1921. (1321) Schneider, 8, 107: 605; 59. (1321.5) Schoch, 11, 41: 208, 232; 09. (1322) Schoch and Felsing, 1, 38: 1928; 16. (1323) Schoen, 192, 8: 737; 11. (1324) Scholvién, *Diss.*, Berlin, 1913. (1325) Schottky, 7, 64: 415; 08. (1326) Schraube, *Diss.*, Berlin Tech. Hoch., 1911. (1327) Schreiber, 7, 24: 651; 97. (1328) Schreinemakers, 7, 68: 83; 09. (1329) Schreinemakers and Figeé, 176, 8: 683; 11.
- (1330) Schreiner, 93, 122: 201; 22. (1331) Schreiner, 7, 111: 419; 24. (1332) Schreiner and Grinnes, 93, 110: 311; 20. (1333) Schübel, 93, 87: 81; 14. (1334) Schümann, 25, 33: 527; 00. (1335) Schumb, 1, 45: 342; 23. (1336) Seelig, *Thesis*, Zürich, 1919. (1337) Seibert, Hulett and Taylor, 1, 39: 38; 17. (1338) Seidell and Smith, 50, 8: 493; 04. (1339) Sénéchal, 34, 156: 552; 13.
- (1340) Seyler and Lloyd, 4, 95: 1347; 09. (1341) Seyler and Lloyd, 4, 111: 138; 17. (1342) Shaffer and Hartmann, 141, 45: 349; 21. (1343) Sherrill, 7, 43: 705; 03. (1344) Sherrill and Noyes, 1, 48: 1861; 26. (1345) Sherrill and Russ, 1, 29: 1661; 07. (1346) Shields, 7, 12: 167; 93. (1347) Sherwood, 45, 17: 745; 25. (1348) Shukoff, 25, 38: 2691; 05. (1348.5) Siegel, 7, 87: 641; 14. (1349) Sieverts, 7, 88: 451; 14.
- (1350) Siggel, 9, 19: 340; 13. (1351) Simons, 1, 46: 2179; 24. (1352) Simons and Hildebrand, 1, 46: 2183; 24. (1353) Sieverts and Fritzsche, 93, 133: 1; 24. (1354) Sieverts and Fritzsche, 93, 133: 17; 24. (1355) Skrabal, 57, 32: 815; 10. (1356) Skrabal, 9, 17: 665; 11. (1357) Skrabal, 75, 123 II: 654; 14. (1358) Skrabal, 57, 35: 1157; 16. (1359) Slade, 9, 17: 261; 11.
- (1360) Slade, 93, 77: 457; 12. (1361) Slade and Farrow, 5, 87: 524; 12. (1362) Slade and Higson, 5, 87: 519; 12. (1363) Slade and Higson, 133, 1913: 451; 14. (1364) Slade and Higson, 135, 108: 166; 14. (1365) Slade and Higson, 4, 115: 215; 19. (1366) Slade and Higson, 4, 115: 205; 19. (1367) Smith, 2, 17: 193; 03. (1368) Smith, 2, 33: 173; 11. (1369) Smith, 1, 40: 879; 18.
- (1370) Smith, 1, 40: 883; 18. (1371) Smith and Calvert, 1, 36: 1363; 14. (1372) Smith and Calvert, 1, 38: 801; 16. (1373) Smith and Carson, 7, 77: 661; 11. (1374) Smith and Holmes, 7, 42: 469; 03. (1375) Smith and Holmes, 7, 54: 257; 05. (1376) Smith and Lombard, 1, 37: 38; 15. (1377) Smith and Lombard, 1, 37: 2055; 15. (1378) Smith and Menzies, 1, 32: 1434; 10. (1379) Smith and Menzies, 1, 32: 1412; 10.
- (1380) Smith and Menzies, 1, 32: 1541; 10. (1381) Smith and Woods, 1, 45: 2632; 23. (1382) Smits, 64V, 32: 353; 23. (1383) Smits and Bokhorst, 64P, 17: 678, 962, 973; 15. (1384) Smits and Bokhorst, 64V, 23: 664, 930, 941; 14. (1385) Smits and Bokhorst, 64P, 18: 106; 15. (1386) Smits and Bokhorst, 7, 91: 249; 16. (1387) Smits, Bokhorst and Terwin, 64P, 16: 1174; 14. (1388) Smits, Meyer and Beck, 64P, 18: 992; 15. (1389) Smits and Wuite, 64V, 18: 225; 09.
- (1390) Smyth, *Thesis*, Mass. Inst. Tech., Boston, 1915. (1390.5) Smyth and Adams, 1, 45: 1167; 23. (1391) Smyth and Roberts, 1, 42: 2582; 20. (1392) Soper, 4, 125: 2227; 24. (1393) Sosman and Hostetter, 1, 38: 807; 16. (1394) Sosman, Hostetter and Mervin, 128, 5: 563; 16. (1395) Spencer, 9, 11: 681; 05. (1396) Sproesser and Taylor, 1, 43: 1782; 21. (1397) Stahl, 192, 4: 682; 07. (1398) Starck, *Diss.*, Stockholm, 1915. (1399) Starck and Bodenstein, 9, 16: 961; 10.
- (1400) Stasevich, 53, 43: 354; 11. (1401) Stegmüller, 9, 16: 85; 10. (1402) Steinwehr, 7, 38: 185; 01. (1403) Stern, 8, 44: 497; 14. (1404) Sterner, *Diss.*, Stuttgart, 1894. (1405) Stock, Henning and Kuss, 25, 54B: 1119; 21. (1406) Stock and Seelig, 25, 52: 672; 19. (1407) Stock, Siecke and Pohland, 25, 57B: 719; 24. (1408) Stoffel, 176, 8: 722; 11. (1409) Stoffella, *Boll. chim. farm.*, 64: 481; 25.
- (1410) Straub, 7, 77: 331; 11. (1411) Strömholm, 93, 38: 429; 04. (1412) Stubbs, 4, 103: 1445; 13. (1413) Sucheini, 9, 12: 726; 06. (1414) Sugden, 4, 1926: 174. (1414.5) Sullivan, 1, 27: 529; 05. (1415) Swan, *see* Harkins, 1, 33: 1807; 11. (1416) Swan, *Thesis*, Mass. Inst. Tech., Boston, 1899. (1417) Szarvasy and Messinger, 25, 30: 1343; 97. (1418) Tamele, 50, 28: 502; 24. (1419) Tammann, 504, 35: No. 9; 87.
- (1420) Tammann, 7, 2: 42; 88. (1421) Tammann, 8, 63: 16; 97. (1422) Tammann, 7, 27: 323; 99. (1423) Tammann, *Kristallisieren und Schmelzen*, 275; 1903. (1424) Tammann and Pape, 93, 127: 43; 23. (1425) Tananaeff, 7, 114: 49; 24. (1426) Taylor, 1, 38: 2295; 16. (1427) Taylor and Hulett, 50, 17: 565; 13. (1428) Taylor and Hulett, 1, 44: 1443; 22. (1429) Taylor and Perrott, 1, 43: 484; 21.
- (1430) Terres and Brückner, 9, 26: 25; 20. (1431) Terres and Pongracz, 9, 25: 386; 19. (1432) Terres and Schaller, 397, 65: 761, 780, 800, 818, 852; 22. (1433) Terwin, *Diss.*, Amsterdam, 1913. (1434) Thiel, 93, 24: 1; 00. (1435) Thiel and Strohecker, 25, 47: 945; 14. (1436) Thin and Cumming, 4, 107: 361; 15. (1437) Thompson, 65, 45: 431; 09. (1438) Thompson, 78, 16: 197; 09. (1439) Thompson, 33, 8: 279, 324; 10.
- (1440) Thompson and Lombard, 65, 46: 247; 10. (1441) Thorpe and Hambly, 4, 55: 163; 89. (1442) Tiede and Birnbrauer, 93, 87: 129; 14. (1443) Tolman and Ferguson, 1, 34: 232; 12. (1444) Tolman and Greathouse, 1, 34: 364; 12. (1445) Trautz, 9, 14: 534; 08. (1446) Trautz, 93, 88: 285; 14. (1447) Trautz, 9, 21: 329; 15. (1448) Trautz, 93, 104: 169; 18. (1449) Trautz and Dalal, 93, 102: 149; 18.
- (1450) Trautz and Geissler, 93, 140: 116; 24. (1451) Trautz and Gerwig, 93, 134: 417; 24. (1452) Trautz and Stäckel, 93, 122: 81; 22. (1453) Trautz and Wackenheim, 93, 97: 241; 16. (1454) Treadwell, 93, 37: 326; 03. (1455) Treadwell and Reuter, 93, 17: 170; 98. (1456) Trimble, 1, 44: 451; 22. (1457) Troost, 34, 88: 578; 79. (1458) Troost, 34, 92: 715; 81. (1459) Troost, 34, 94: 789; 82.
- (1460) Troost and Hautefeuille, 34, 66: 795; 68. (1461) Troost and Hautefeuille, 34, 78: 686; 74. (1462) Troost and Hautefeuille, 6, 2: 273; 74. 34, 78: 807; 74. (1463) Truthe, 93, 76: 161; 12. (1463.5) Unmach and Bjerrum, *see* (121). (1464) Vágó, *Thesis*, Budapest. (1465) Valenta, 75, 103 IIb: 191; 94. 57, 15: 249; 94. (1466) Van Name and Brown, 12, 44: 105; 17. (1467) Van Name and Brown, 12, 44: 453; 17. (1468) Varet, 6, 8: 79; 96. (1469) Villard, 34, 106: 1062; 88.
- (1470) Villard, 34, 107: 395; 88. (1471) Villard, 34, 120: 1262; 95. (1472) Villard, 51, 5: 453; 97. (1473) Villard, 6, 11: 289; 97. (1474) Virek, 185, 1862: 402. (1475) Voerkelius, *Diss.*, Hanover, 1909. (1476) Voerkelius, 136, 33: 1078, 1090; 09. (1477) Vohlendorff, *Diss.*, Berlin, 1891. (1478) Volhard, 25, 7: 92; 74. (1479) Volquartz, *see* (207).
- (1480) Vosburgh, 1, 47: 2531; 25. (1481) Vosburgh, *O. See* (471). (1482) Vosburgh, 1, 49: 2222; 27. (1482.1) Wreusky, 7, 112: 109; 24. (1482.2) Wreusky, Sawaritzky and Scharloff, 7, 112: 97; 24. (1483) Waddell, 50, 2: 525; 98. (1484) Waidner and Burgess, 31A, 6: 149; 10. (1485) Walden, 7, 2: 49; 88. (1486) Walden, 1, 30: 1350; 08. (1487) Walden and Centnerszwer, 7, 42: 432; 03. (1488) Walker, 7, 42: 207; 02. (1489) Walker, 4, 127: 61; 25.
- (1490) Walker, Bray and Johnston, 1, 49: 1235; 27. (1491) Walker and Carmack, 4, 77: 5; 00. (1492) Walker and Hambley, 4, 67: 746; 95. (1493) Walker and Lumsden, 4, 71: 428; 97. (1494) Walker and Kay, 4, 71: 489; 97. (1495) von Wartenberg, 7, 56: 513; 06. (1496) von Wartenberg, 88, 8: 97; 06. (1497) von Wartenberg, 93, 52: 299; 07. (1498) von Wartenberg, 93, 56: 320; 08. (1499) von Wartenberg, 93, 79: 71; 12.
- (1500) von Wartenberg, 9, 19: 489; 13. (1501) von Wartenberg, 9, 19: 482; 13. (1502) von Wartenberg, 9, 20: 443; 14. (1503) von Wartenberg, 7, 110: 285; 24. (1504) von Wartenberg and Sieg, 25, 53: 2192; 20. (1505) von Wartenberg and Weigel, 93, 142: 337; 25. (1506) Wasastjerna, 138, 1: No. 39; 23. (1507) Washburn and Strachan, 1, 35: 681; 13. (1508) Wasjuchnowa, *Diss.*, Berlin, 1909. (1509) Weber, 93, 21: 305; 99.
- (1510) Wegscheider, 7, 65: 97; 09. (1511) Weigert, 8, 24: 55; 07. (1512) von Weimarn, 7, 76: 212; 11. (1513) Weisberg, *Thesis*, Mass. Inst. Tech., Boston, 1915. (1514) Wells, 128, 5: 617; 15. (1515) Wells, 128, 5: 491; 15. (1516) Wells and McAdams, 1, 29: 721; 07. (1517) Wenger, *Thesis*, Geneva, 1911. (1518) Wescott, 1, 42: 1335; 20. (1519) Whitby, 93, 67: 107; 10.
- (1520) White, *O. See* (939). (1521) White and Kirschbaum, 1, 28: 1343; 06. (1522) Whitman and Evans, 33, 27: 686; 22. (1523) Whitney and Melcher, 1, 25: 69; 03. (1524) Wiedemann, 8, Jubelband: 481. (1525) Wiedemann, Stelzner and Niederschulte, 26, 3: 159; 05. (1526) Wigand, 7, 75: 235; 11. (1527) Wilhelm, 143, 182: 525; 16. (1528) Wilhelm, 31, No. 204; 1916. (1529) Wilcox and Pridaux, 4, 127: 1543; 25.
- (1530) Williams, *Thesis*, University of California, 1922. (1531) Wilson, 1, 43: 704; 21. (1532) Winkler, *Diss.*, Leipzig, 1910. (1533) Winteler, 9, 7: 360; 00. (1534) Wirth, 93, 76: 174; 12. (1535) Wirth, 93, 79: 357; 13. (1536) Wirth, 93, 87: 9; 14. (1537) Wöhler, 9, 12: 781; 06. (1538) Wöhler and Balz, 9, 27: 406; 21. (1539) Wöhler and Grünzweig, 25, 46: 1726; 13. (1540) Wöhler and Grünzweig, 25, 46: 1587; 13. (1541) Wöhler and Gunther, 9, 29: 276; 23. (1542) Wöhler and Prager, 9, 23: 199; 17. (1543) Wöhler

and Streicher, 25, 46: 1577; 13. (1544) Wöhler and Streicher, 25, 46: 1591; 13. (1544.5) Wörmann, 8, 18: 775; 05. (1545) Wohl, 7, 110: 166; 24. (1546) Wohl, 9, 30: 36; 24. (1547) Wohl, 9, 30: 49; 24. (1548) Wolff, 9, 20: 19; 14. (1549) Wolfenstein, 25, 27: 3307; 94. (1550) Wood, 4, 93: 411; 08. (1551) Wood, 4, 97: 878; 10. (1552) Worthing, 2, 10: 377; 17. (1553) Wourtel, 34, 169: 1397; 19. (1554) Wroblewski,

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OPTICAL ROTATORY POWER OF SOLID CRYSTALS

W. T. ASTBURY

Optically active crystals exist in two enantiomorphous forms having equal and opposite rotatory powers for light of a given wave-length. No isotropic substances (cubic crystals) exhibit optical rotation when in solution, but some do when in crystal form. Rotatory power = θ/l where θ is the angle through which the plane of polarization is rotated while plane polarized light is passing a distance l through the crystal in the direction of an optic axis. In some cases the variation of θ/l with the wave-length (λ) can be represented by an empirical Drude equation $\theta/l = k/(\lambda^2 - \lambda_0^2)$. Temperature is stated whenever it is given in the published paper, in other cases it is presumably room temperature. $t[T]$ = centigrade ($^{\circ}\text{C}$) [absolute ($^{\circ}\text{K}$)] temperature. Iso = isotropic (cubic crystal), Uni = uniaxial, Bi = biaxial, d - [l] = dextro- [levo-] rotatory. " d -solutions $\rightarrow l$ -crystals" means that levorotatory crystals form from a solution which is dextrorotatory. Yes [No] means that solutions of the substance are [are not] active. A = accuracy; example: For HIO_3 , $\lambda = 0.436$, $\theta/l = (74.5 \pm 0.7)$ degrees per mm.

B-TABLE, STANDARD ARRANGEMENT

Unit of θ/l and of $A = 1^{\circ}$ per mm; of $\lambda = 1\mu = 10^4 \text{ \AA} = 10^{-4} \text{ cm}$

HIO₃ Iodic acid (12), Bi, No, dimorphous, both forms are orthorhombic bisphenoidal; prism angle of specimen = $86^{\circ}23'$

λ	θ/l	A
0.436	74.5	0.7
0.546	58.7	0.6
0.579	50.5	0.5

N₂H₄·H₂SO₄, Hydrazine sulfate (12), Bi, No

λ	θ/l	A
0.436	4.00	0.08
0.546	3.05	0.06
0.579	2.80	0.06

C-Compounds, v. p. 354

SiO₂, v. Vol. VI, p. 342

PbS₂O₆·4H₂O, Lead dithionate (18, 19), Uni, No, 20°C

λ	θ/l	A
0.5461	6.57	0.03
0.5893	5.46	0.03

If $0.4047 < \lambda < 0.7188$, $k = 1.601$, $\lambda_0^2 = 0.0541$, $A = 1\%$ of k

Pb(CHO₂)₂, Lead formate (12), Bi, No

λ	θ/l	A
0.436	39.4	2.0
0.546	18.0	0.9
0.579	15.6	0.8

ZnSO₄·7H₂O, Zinc sulfate (12), Bi, No

λ	θ/l	A
0.436	4.05	0.08
0.546	2.72	0.05
0.579	2.41	0.04

Zn(C₄H₅O₅)₂·2H₂O, Zinc malate (25), Uni, Yes, l -crystals $\rightarrow l$ -solutions

λ	θ/l	A
0.5893	3.0	0.2

HgS, Cinnabar* (17, 19), Uni, No, 20°C

λ	θ/l	A
0.5893	560	10
0.6022	480	8
0.7188	140	5

If $0.6103 < \lambda < 0.6870$, $k = 33.65$, $\lambda_0^2 = 0.2915$, $A = 1\%$ of k

* For $\lambda = 0.6438$, $(\theta/l)T = 237.5 \times (1.00421 - 0.00056T + 0.00000355T^2)$, $A = 0.5\%$, $87^{\circ}\text{K} < T < 277^{\circ}\text{K}$; and $(\theta/l)_t = 264(1 + 0.001t)$, $A = 1\%$, $4^{\circ}\text{C} < t < 22^{\circ}\text{C}$. For $\lambda = 0.6708$, $t = -184.5^{\circ}\text{C}$, $\theta/l = 190 \pm 1$; for $\lambda = 0.5893$, $t = -187.4^{\circ}\text{C}$, $\theta/l = 142 \pm 1$. See (17, 19).

NiSO₄·7H₂O, Nickel sulfate (12), Bi, No

λ	θ/l	A
0.546	6.30	0.31
0.579	6.10	0.30

(MoO₄)₂·C₄H₆O₅(NH₄)₂·2H₂O, Ammonium molybdomalate (12), Bi, Yes, d -solutions $\rightarrow l$ -crystals

λ	θ/l	A
0.436	72.87	0.73
0.546	37.2	0.4
0.579	32.3	0.3
0.5893	30.8	0.3

MgSO₄·7H₂O, Magnesium sulfate (12), Bi, No

λ	θ/l	A
0.436	3.18	0.03
0.546	2.30	0.02
0.579	1.98	0.02

MgCrO₄·7H₂O, Magnesium chromate (12), Bi, No

λ	θ/l	A
0.436	8.13	0.08
0.546	6.74	0.07
0.579	5.59	0.06

CaS₂O₆·4H₂O, Calcium dithionate (19), Uni, No, 20°C

λ	θ/l	A
0.5461	2.74	0.05
0.5893	2.10	0.04

If $0.4047 < \lambda < 0.7188$, $k = 0.702$, $\lambda_0^2 = 0.0133$, $A = 2\%$ of k

SrS₂O₆·4H₂O, Strontium dithionate (19), Uni, No, 20°C

λ	θ/l	A
0.5461	3.27	0.03
0.5893	2.78	0.03

If $0.4047 < \lambda < 0.6868$, $k = 0.894$, $\lambda_0^2 = 0.025$, $A = 1\%$ of k

Sr(CHO₂)₂·2H₂O, Strontium formate (12), Bi, No

λ	θ/l	A
0.436	2.0	0.2
0.546	1.0	0.1
0.579	0.75	0.08

Ba(MoO₄)₂·C₄H₆O₅·2H₂O, Barium molybdomalate (12), Bi, Yes

λ	θ/l	A
0.436	78.3	0.8
0.546	41.5	0.4
0.579	33.96	0.34
0.5893	31.68	0.32

NaClO₃, Sodium chlorate* (8, 21, 26), Iso, No, 20°C

λ	θ/l	A
0.5461	3.69	0.02
0.5893	3.16	0.01

If $0.3184 < \lambda < 0.7188$, $k = 1.078$, $\lambda_0^2 = 0.0062$, $A = 0.5\%$ of k

* $(\theta/l)_t = (\theta/l)_0 \{1 + \beta t(10)^{-5}\}$; Guye (8) found $\beta = 59 \pm 1$ if $0^{\circ}\text{C} < t < 31^{\circ}\text{C}$ and $0.3821 < \lambda < 0.5893$; Sohneke (21) found $\beta = 61 \pm 6$ if $16^{\circ}\text{C} < t < 148^{\circ}\text{C}$ and $0.4862 < \lambda < 0.5893$.

NaBrO₃, Sodium bromate (19, 22), Iso, No, 20°C

λ	θ/l	A
0.4047	7.2	0.1
0.5461	2.62	0.02
0.5893	2.13	0.02
0.7188	1.39	0.04

If $0.4102 < \lambda < 0.6867$, $k = 0.541$, $\lambda_0^2 = 0.092$, $A = 1\%$ of k

NaIO₄·3H₂O, Sodium periodate (7), Uni, No

λ	θ/l	A
0.4308	47.1	0.7
0.4862	34.2	0.2
0.5270	28.5	0.4
0.5893	23.3	0.1
0.6563	19.4	0.5

NaH₂PO₄·2H₂O, Sodium dihydrogen phosphate (6), Bi, No

λ	θ/l	A
0.5893	4.5	0.4

Na₃SbS₄·9H₂O, Sodium sulfantimoniate (16), Iso, No

λ	θ/l	A
0.556	2.7	0.3

NaNH₄C₄H₄O₆·4H₂O, Sodium ammonium tartrate (6), Bi, Yes, d -solutions $\rightarrow l$ -crystals

λ	θ/l	A
0.5893	1.55	0.15

NaUO₂(C₂H₃O₂)₃, Sodium uranyl acetate (22), Iso, No

λ	θ/l	A
0.5893	1.48	0.05

K₂S₂O₆, Potassium dithionate (18, 19), Uni, No, 20°C

λ	θ/l	A
0.5461	9.67	0.05
0.5893	8.20	0.04

If $0.4047 < \lambda < 0.7188$, $k = 2.664$, $\lambda_0^2 = 0.0225$, $A = 1\%$ of k

K₃Ir(C₂O₄)₃·H₂O, Potassium iridium trioxalate (15), Uni, Yes

λ	θ/l	A
0.579	12.0	0.6

$K_3Rh(C_2O_4)_3 \cdot H_2O$, Potassium rhodium trioxalate (14), Uni, Yes, solution has similar dispersion of rotation, but inversion is at $\lambda = 0.597$ instead of 0.519

λ	θ/l	A
0.490	+5.1	0.1
0.500	+2.8	0.06
0.520	-1.0	0.02
0.540	-2.6	0.05
0.560	-4.8	0.1
0.580	-6.4	0.1
0.600	-7.4	0.1
0.620	-8.4	0.2
0.640	-8.9	0.2
0.660	-9.1	0.2
0.680	-8.8	0.2
0.700	-8.4	0.2

$K_4Mo_{12}SiO_{40} \cdot 18H_2O$, Potassium silicomolybdate (4), Uni, No

0.5893	17.2	0.3
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C-TABLE, STANDARD ARRANGEMENT v. Vol. III, p. viii

$(COONH_4)_2 \cdot H_2O$, Ammonium oxalate (12), Bi, No

λ	θ/l	A
0.436	20.0	0.4
0.546	13.7	0.3
0.579	12.0	0.2

$C_2H_4(NH_2)_2 \cdot H_2SO_4$, Ethylenediamine sulfate (11), Uni, No

0.5893	15.5	0.3
--------	------	-----

$(CH_5N_3)_2 \cdot H_2CO_3$, Guanidine carbonate (2), Uni, No

0.5351	17.1	0.2
0.5893	14.6	0.3
0.6708	12.6	0.1

$C_4H_4O_6$, Tartaric acid (13), Bi, Yes, d -solutions (aqueous) $\rightarrow l$ -crystals

0.436	24.0	0.2
0.546	13.0	0.1
0.589	10.7	0.1
0.650	9.1	0.1

If $0.480 < \lambda < 0.600$, $k = 2.80$, $\lambda_0^2 = 0.0839$, $A = 1\%$ of k

$K_4W_{12}SiO_{40} \cdot 18H_2O$, Potassium silicotungstate (30), Uni, No

λ	θ/l	A
0.5893	14.4	0.2

$LiKSO_4$, Lithium potassium sulfate (23), Uni, No

0.5893	3.5	0.2
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$K_2SO_4 \cdot Li_2CrO_4$, Potassium lithium sulfochromate (23), Uni, No

0.5893	1.9	0.2
--------	-----	-----

$KNaC_4H_4O_6 \cdot 4H_2O$, Rochelle salt (6), Bi, Yes, d -solutions $\rightarrow d$ -crystals

0.5893	1.35	0.15
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$Rb_2C_4H_4O_6$, Rubidium tartrate (24, 29), Uni, Yes, d -solutions $\rightarrow l$ -crystals

0.5893	10.4	0.2
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$Cs_2C_4H_4O_6$, Cesium tartrate (24), Uni, Yes, d -solutions $\rightarrow l$ -crystals

0.5893	17	3
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$C_4H_4O_6(NH_4)_2$, Ammonium tartrate (12), Bi, Yes

λ	θ/l	A
0.436	16.0	0.3
0.546	14.0	0.3
0.579	8.9	0.2
0.5893	8.8	0.2

$C_4H_4O_6(SbO)NH_4 \cdot H_2O$, Ammonium antimonyl tartrate (27), Bi, Yes

0.491	24.9	0.6
0.536	18.5	0.4
0.570	16.8	0.4
0.620	13.9	0.3

$C_4H_8N_2O_3 \cdot H_2O$, Asparagine (12), Bi, Yes, l -solutions $\rightarrow l$ -crystals

0.436	9.7	0.2
0.546	7.2	0.1
0.579	6.2	0.1
0.5893	5.9	0.1

$C_6H_{12}O_6$, Quercitol (10), Bi, Yes

"Weak" axis
0.5461 4.5 0.2
0.5893 3.7 0.2
If $0.4862 < \lambda < 0.6868$, $k = 1.04$, $\lambda_0^2 = 0.067$, $A = 4\%$ of k

"Strong" axis
0.5270 6.4 0.4
0.5550 5.9 0.3
0.5893 4.6 0.3
0.6563 3.9 0.3

$C_7H_{14}O_6$, d -Methyl- α -glucoside (6), Bi, Yes, d -solution $\rightarrow d$ -crystals

λ	θ/l	A
0.5893	4.4	0.3

$C_{10}H_{16}O$, Camphor (common, Laurus) (20), Uni, Yes

0.4308	1.82	0.02
0.5893	0.65	0.01
0.6868	0.46	0.01

$C_{12}H_{20}O$, Matico camphor (9, 24), Uni, Yes

0.5351	2.47	0.05
0.5893	1.98	0.06
0.6708	1.68	0.05

$C_{14}H_{10}O_2$, Benzil (5), Uni, No

0.5893	25.0	0.3
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$C_{16}H_{26}O$, Patchouli camphor (24), Uni, Yes. All crystals seen were levo

0.5893	1.33	0.02
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$C_{17}H_{20}O$, Benzylidenecamphor (12), Bi, Yes, d -solutions $\rightarrow d$ -crystals

0.436	20.2	0.4
0.546	10.0	0.2
0.579	8.6	0.2
0.5893	8.18	0.16

$C_{18}H_{22}O_2$, Anisalcamphor (12), Bi, Yes, d -solutions $\rightarrow l$ -crystals

λ	θ/l	A
0.436	82.0	0.8
0.546	44.0	0.4
0.579	38.0	0.4
0.5893	36.2	0.4

$C_{20}H_{23}NO_4$, d -Corydine (1), Uni, Yes

0.5351	14.6	0.2
0.5893	13.2	0.2
0.6708	10.5	0.2

$C_{24}H_{18}O_6$, Diacetylphenolphthalein (3), Uni, No

0.5351	23.8	0.2
0.5893	19.8	0.1
0.6708	17.1	0.2

$(C_{19}H_{24}N_2O)_2 \cdot H_2SO_4 \cdot 11H_2O$, Hydrocinchonine sulfate (31), Uni, Yes, all crystals are dextro

0.5893	12.8	0.1
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$(C_{21}H_{22}N_2O_2)_2 \cdot H_2SO_4 \cdot 6H_2O$, Strychnine sulfate (22, 31), Uni, Yes, l -crystals $\rightarrow l$ -solutions

0.5893	13.25	(?)
0.5893	10.9	(?)

$(C_{19}H_{24}N_2O)_2(SbO)_2C_4H_4O_6 \cdot 5H_2O$, Cinchonine antimonyl tartrate (25), Uni, Yes, d -solution $\rightarrow d$ -crystals

0.5893	9.8	0.1
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$(C_{19}H_{22}N_2O)_2 \cdot C_4H_6O_4 \cdot 6H_2O$, Apocinchonine succinate (28), Uni, Yes

0.5893	3.5	0.5
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LITERATURE

(For a key to the periodicals see end of volume)

- (1) Blass, 94, 48: 20; 11. (2) Bodewig, 8, 157: 122; 76. (3) Bodewig, 94, 1: 72; 77. (4) Copaux, 6, 7: 118; 06. (5) Des Cloizeaux, 34, 68: 308; 69. 70: 1209; 70. (6) Dufet, 51, 3: 757; 04. (7) Groth, 8, 137: 433; 69. (8) Guye, 149, 22: 130; 89. (9) Hintze, 8, 157: 127; 76. (10) Karandeev, 134, 9: 1285; 15. (11) von Lang, 75, 65 II: 30; 72. (12) Longchambon, 191, 45: 161; 22. 34, 172: 1187; 21. 173: 89; 21. 175: 174; 22. Thesis, Paris, 1923. (13) Longchambon, 34, 178: 951; 24. (14) Longchambon, 34, 178: 1828; 24. (15) Longchambon, Univ. Nancy, 0. (16) Marbach, 8, 99: 451; 56. (17) Molby, 2, 31: 291; 10. (18) Pape, 8, 139: 224; 70. (19) Rose, 190B, 29: 53; 10. (20) von Seher-Thoss, in Traube, 94, 23: 577; 94. (21) Sohncke, 8, 3: 516; 78. (22) Traube, B3, 2nd ed., 1894; p. 459, 460. (23) Traube, 190, 1: 171; 94. (24) Traube, 76, 1895: 195. (25) Traube, 190B, 11: 623; 97. (26) Voigt, 63, 9: 585; 08. (27) Wallerant, 34, 158: 91; 14. (28) Wyruboff, 6, 1: 5; 94. (29) Wyruboff, 51, 3: 451; 94. (30) Wyruboff, 191, 19: 219; 96. (31) Wyruboff, 191, 24: 76; 01.

OPTICAL ROTATORY POWER OF LIQUIDS AND SOLUTIONS¹

THOMAS MARTIN LOWRY

ARRANGEMENT

Arrangement is by classes defined as follows:

Carbon Compounds*

- I. None of the asymmetric carbon atoms forms part of a ring.
- II. At least one asymmetric carbon atom forms part of a ring.
- III. The compound contains no asymmetric carbon atom or contains at least one asymmetric or dissymmetric atom other than carbon.

IV. Substances of unknown, doubtful or complex structure.

Classes I to IV are subdivided according to the number and nature of the asymmetric atoms as follows:

- A_n The molecule contains n asymmetric atoms which are attached each to only one other carbon atom.
- B_n The molecule contains n asymmetric atoms which are attached each to two other carbon atoms.
- C_n The molecule contains n asymmetric atoms which are attached each to three other carbon atoms.
- D_n The molecule contains n asymmetric atoms which are attached each to four other carbon atoms.

For substances which fall within two or more of the above subdivisions the higher (in the order D, C, B, A) division receives preference in deciding the arrangement. Within a subdivision the arrangement is in accordance with the value of n in the order 1, 2, 3, etc.

SYMBOLS AND ABBREVIATIONS

- t Temperature in degrees centigrade ($^{\circ}\text{C}$).
- λ Wave length of light expressed in Ångstrom units, *i.e.*, in tenths of a millimicron ($\frac{1}{10}\mu\mu$) unless otherwise indicated.
- D A wave length of 5893 Å.
- α_{λ}^t Observed rotation at the given values for t .
- $[\alpha]_{\lambda}^t$ Specific rotation at the given values for t .
- $[M]_{\lambda}^t$ Molecular rotation at the given values for t ($= M \times [\alpha]_{\lambda}^t / 100$).
- C Concentration in grams per 100 cm^3 of solution.
- $\%$ Concentration in grams per 100 grams of solution ($= \text{Wt. } \%$). (Values in italics.)
- d d_4^t = density at the given value for t referred to water at 4°C , unless otherwise indicated.
- 2% NaOH (etc.) 2% of solution of NaOH in water.
- 2% NaOH MeOH 2% of solution of NaOH in methyl alcohol.
- M Moles.
- N NaOH Normal aqueous solution of NaOH ($= 1$ equivalent/liter).

ARRANGEMENT

Arrangement par classes, définies comme suit:

Composés du carbone

I. Aucun des atomes de carbone asymétriques ne fait partie d'une chaîne cyclique.

II. Un atome de carbone asymétrique au moins fait partie d'une chaîne cyclique.

III. Le composé ne contient aucun atome de carbone ou contient au moins un atome asymétrique ou dyssymétrique autre que carbone.

IV. Substances de structure inconnue, douteuse ou complexe.

Les classes I-IV sont subdivisées comme suit, en accord avec le nombre et la nature des atomes asymétriques:

- A_n La molécule contient n atomes asymétriques, chacun de ceux-ci étant seulement relié à un autre atome de carbone.
- B_n La molécule contient n atomes asymétriques, chacun de ceux-ci étant relié à deux autres atomes de carbone.
- C_n La molécule contient n atomes asymétriques, chacun de ceux-ci étant relié à trois autres atomes de carbone.
- D_n La molécule contient n atomes asymétriques, chacun de ceux-ci étant relié à quatre autres atomes de carbone.

Lorsqu'une substance est comprise dans deux ou plusieurs subdivisions ci-dessus, on donnera la préférence à la division supérieure (dans l'ordre D, C, B, A) pour décider de l'arrangement. Dans une subdivision, l'arrangement est réalisé en accord avec les valeurs de n , dans l'ordre 1, 2, 3, etc.

SYMBOLES ET ABRÉVIATIONS

- t Température en degrés centigrades ($^{\circ}\text{C}$).
- λ Longueur d'onde de la lumière exprimée en unités Ångstrom, *i.e.*, en dixièmes de millimicron ($\frac{1}{10}\mu\mu$) à moins d'une autre indication.
- D Une longueur d'onde de 5893 Å.
- α_{λ}^t Rotation observée pour les valeurs données de t .
- $[\alpha]_{\lambda}^t$ Rotation spécifique pour les valeurs données de t .
- $[M]_{\lambda}^t$ Rotation moléculaire pour les valeurs données de t ($= M \times [\alpha]_{\lambda}^t / 100$).
- C Concentration en grammes pour 100 cm^3 de solution.
- $\%$ Concentration en grammes pour 100 grammes de solution ($= \text{Pds. } \%$). (Valeurs en italique.)
- d d_4^t = densité pour la valeur donnée de t par rapport à l'eau à 4°C , à moins d'une autre indication.
- 2% NaOH (etc.) Solution de NaOH dans l'eau, à 2%.
- 2% NaOH MeOH Solution à 2% de NaOH dans l'alcool méthylique.
- M Molécule-gramme ou mole.
- N NaOH Solution aqueuse normale de NaOH ($= 1$ équivalent/litre).

Symbols for Solvents

- A = The acid radical under which it is used.
- Ac = (CH_3CO) Acetyl.
- Bu = (C_3H_7) Butyl.
- En = $(\text{C}_2\text{H}_5\text{N}_2)$ α, β -Ethylenediamine.
- Et = (C_2H_5) Ethyl.

- Me = (CH_3) Methyl.
- Ph = (C_6H_5) Phenyl.
- Pn = $(\text{C}_3\text{H}_{10}\text{N}_2)$ α, β -Propylenediamine.
- Py = $(\text{C}_5\text{H}_5\text{N})$ Pyridine.
- Tr = $(\text{C}_3\text{H}_{10}\text{N}_2)$ α, γ -Diaminopropane.

¹ This section includes data and bibliography to January 1, 1924. * Sugars and their derivatives (see also Vol. II, p. 334, 353) are classed as open chain compounds. In general, derivatives are listed under the parent compound, even when they contain additional asymmetric atoms.

ANORDNUNG

Die Anordnung erfolgt nach Klassen, die folgendermassen bestimmt sind:

Kohlenstoffverbindungen

I. Keines der asymmetrische Kohlenstoffatome bildet einen Teil eines Ringes.

II. Wenigstens ein asymmetrisches Kohlenstoffatom bildet einen Teil eines Ringes.

III. Die Verbindung enthält kein asymmetrisches Kohlenstoffatom oder enthält wenigstens ein asymmetrisches oder dissymmetrisches Atom von anderer Natur als Kohlenstoff.

IV. Stoffe unbekannter, zweifelhafter oder komplexer Struktur.

Die Klassen I–IV werden weiter geteilt nach der Zahl und Natur der asymmetrischen Atome wie folgt:

A_n Das Molekül enthält n asymmetrische Atome, von denen jedes an nur ein anderes Kohlenstoffatom gebunden ist.

B_n Das Molekül enthält n asymmetrische Atome, von denen jedes an zwei andere Kohlenstoffatome gebunden ist.

C_n Das Molekül enthält n asymmetrische Atome, von denen jedes an drei andere Kohlenstoffatome gebunden ist.

D_n Das Molekül enthält n asymmetrische Atome, von denen jedes an vier andere Kohlenstoffatome gebunden ist.

Für Stoffe die in zwei oder mehr der obigen Unterabteilungen fallen, erhält die höhere Abteilung (in der Reihenfolge D, C, B, A) bei der Entscheidung der Anordnung den Vorzug. Innerhalb einer Unterabteilung erfolgt die Anordnung entsprechend dem Werte von n in der Reihenfolge 1, 2, 3, usw.

ZEICHEN UND ABKÜRZUNGEN

t	Temperatur in Celsiusgraden ($^{\circ}\text{C}$).
λ	Lichtwellenlänge ausgedrückt in Ångstrom Einheiten, d.h., in Zehnteln eines Millimikrons ($\frac{1}{10}\mu\mu$), wenn nicht anders angegeben.
D	Wellenlänge 5893 Å.
α_t^t	Beobachtete Drehung bei den gegebenen Werten für t .
$[\alpha]_t^t$	Spezifische Drehung bei den gegebenen Werten für t .
$[M]_t^t$	Molekulare Drehung bei den gegebenen Werten für t ($= M \times [\alpha]_t^t/100$).
C	Konzentration in Gramm pro 100 cm^3 Lösung.
%	Konzentration in Gramm pro 100 Gramm Lösung (= Gew. %). (Werte in Kursivschrift.)
d	d_4^t = Dichte bei dem gegebenen Wert für t (bezogen auf Wasser bei 4°C , wenn nicht anders angegeben).
2% NaOH (usw.)	2%-ige Lösung von NaOH in Wasser.
2% NaOH MeOH	2%-ige Lösung von NaOH in Methylalkohol.
M	Mole
N NaOH	Normale wässrige Lösung von NaOH (= 1 Äquivalent/Liter).

DISPOSIZIONE

La disposizione è fatta secondo classi definite come segue:

Composti del carbonio

I. Nessuno degli atomi di carbonio asimmetrici fa parte di un anello.

II. Almeno un atomo di carbonio asimmetrico fa parte di un anello.

III. Il composto contiene nessuno atomo asimmetrico di carbonio o contiene almeno un atomo asimmetrico o dissimmetrico diverso dal carbonio.

IV. Sostanze di struttura sconosciuta, incerta o complessa.

Le classi I–IV sono suddivise secondo il numero e la natura degli atomi asimmetrici nella maniera seguente:

A_n La molecola contiene n atomi asimmetrici i quali sono attaccati ciascuno a un altro atomo di carbonio soltanto.

B_n La molecola contiene n atomi asimmetrici i quali sono attaccati ciascuno a due altri atomi di carbonio.

C_n La molecola contiene n atomi asimmetrici i quali sono attaccati ciascuno a tre altri atomi di carbonio.

D_n La molecola contiene n atomi asimmetrici che sono attaccati ciascuno a quattro atomi di carbonio.

Per le sostanze che rientrano in due o più delle suddivisioni indicate, la divisione più alta (nell'ordine D, C, B, A) ha la preferenza nel decidere la disposizione. Entro ciascuna suddivisione la disposizione è d'accordo con il valore di n nell'ordine 1, 2, 3, ecc.

SIMBOLI ED ABBREVIAZIONI

t	Temperatura in gradi centigradi ($^{\circ}\text{C}$).
λ	Lunghezza d'onda della luce espressa in unità Ångstrom, i.e., in decimi di millimicron ($\frac{1}{10}\mu\mu$) tranne che non sia altrimenti indicato.
D	Una lunghezza d'onda di 5893 Å.
α_t^t	Rotazione osservata ai valori di t indicati.
$[\alpha]_t^t$	Rotazione specifica ai valori di t indicati.
$[M]_t^t$	Rotazione molecolare ai valori dati per t ($= M \times [\alpha]_t^t/100$).
C	Concentrazione in grammi per 100 cm^3 di soluzione.
%	Concentrazione in grammi per 100 grammi di soluzione (= % in peso). (Valori scritti in caratteri italici.)
d	d_4^t = densità al valore di t indicato, riferita all'acqua a 4°C salvo che non sia indicato altrimenti.
2% NaOH (ecc.)	2% di soluzione di NaOH in acqua.
2% NaOH MeOH	2% di soluzione di NaOH in alcool metilico.
M	Moli.
N NaOH	Soluzione acquosa normale di NaOH (= 1 equivalente/litro).

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* For further data on these compounds at various temperatures, with other wave lengths, and in various solvents, see the forthcoming article by Professor Lowry, Miscellaneous Publications, Bureau of Standards, No. 118, 1931.

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* For further data on these compounds at various temperatures, with other wave lengths, and in various solvents, see the forthcoming article by Professor Lowry, Miscellaneous Publications, Bureau of Standards, No. 118, 1931.

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* For further data on these compounds at various temperatures, with other wave lengths, and in various solvents, see the forthcoming article by Professor Lowry, Miscellaneous Publications, Bureau of Standards, No. 118, 1931.

Class I. ORGANIC SUBSTANCES, THE ASYMMETRIC CARBON ATOMS OF WHICH DO NOT FORM PART OF A RING
 IB₁. The Molecule Contains One Asymmetric Atom Attached to Two Other Carbon Atoms
 SIMPLE HALIDES

Formula	Name	d_4^{20}	$t, ^\circ\text{C}$	$[\alpha]_D$	Lit.
$\text{C}_4\text{H}_9\text{I}$	<i>l</i> - β -Iodobutane.....	1.5970	17	-31.98	(1619)
$\text{C}_5\text{H}_{11}\text{I}$	<i>l</i> - β -Iodopentane.....	1.5067	17	-37.15	(1619)
$\text{C}_6\text{H}_{13}\text{I}$	<i>l</i> - β -Iodoheptane.....	1.4354	17	-38.35	(1619)
$\text{C}_8\text{H}_9\text{Cl}$	<i>l</i> - α -Chloroethylbenzene.....	1.0642	17	-5.80	(1619)
$\text{C}_8\text{H}_{17}\text{Br}$	<i>d</i> - β -Bromooctane.....	1.0895	17	+27.53	(1619)
	<i>l</i> - β -Bromooctane.....		4	-31.07	(1619)
		1.0927 ^{13.8} ₄	13.1	-30.33	
		1.0914 ¹⁷ ₄	17	-27.47	
		1.0805 ²⁶ ₄	30	-29.05	
		1.0688 ³⁷ ₄	37	-28.62	
		1.0532 ⁵³ ₄	50	-27.81	
			92	-25.18	
$\text{C}_8\text{H}_{17}\text{Cl}$	<i>l</i> - β -Chlorooctane.....	0.8628	17	-20.44	(1619)
	<i>d</i> - β -Chlorooctane.....	0.8658	17	+20.40	(1619)
$\text{C}_8\text{H}_{17}\text{I}$	<i>l</i> - β -Iodooctane.....	1.3299	17	-40.56	(1619)
	<i>d</i> - β -Iodooctane.....	1.3314	17	+39.82	(1619)
$\text{C}_9\text{H}_{11}\text{Cl}$	<i>l</i> - α -Chloropropylbenzene.....	1.0430	17	-3.87	(1619)
	<i>d</i> - α -Chloropropylbenzene.....	1.0429	17	+3.79	(1619)
$\text{C}_9\text{H}_{19}\text{Br}$	<i>l</i> - γ -Bromononane.....	1.0897	17	-13.39	(1619)
	<i>d</i> - γ -Bromononane.....	1.0900	17	+12.90	(1619)
$\text{C}_9\text{H}_{19}\text{Cl}$	<i>l</i> - γ -Chlorononane.....	0.8540	17	-8.03	(1619)
	<i>d</i> - γ -Chlorononane.....	0.8588	17	+7.71	(1619)
$\text{C}_9\text{H}_{19}\text{I}$	<i>l</i> - γ -Iodononane.....	1.2873	17	-17.50	(1619)
	<i>d</i> - γ -Iodononane.....	1.2940	17	+17.65	(1619)

ALCOHOLS

MONOHYDROXY ALCOHOLS, THIOLS AND THEIR ESTERS

Methyl carbinols, RCH_2CHOH (1619); cf. (812)

Formula	R	$[\alpha]_D^{20}$
$\text{C}_4\text{H}_{10}\text{O}$	Ethyl	13.87
$\text{C}_5\text{H}_{12}\text{O}$	<i>n</i> -Propyl	13.70
$\text{C}_6\text{H}_{14}\text{O}$	<i>n</i> -Butyl	11.57
$\text{C}_7\text{H}_{16}\text{O}$	<i>n</i> -Amyl	10.32
$\text{C}_8\text{H}_{18}\text{O}$	<i>n</i> -Hexyl	9.76
$\text{C}_9\text{H}_{20}\text{O}$	<i>n</i> -Heptyl	8.99
$\text{C}_{10}\text{H}_{22}\text{O}$	<i>n</i> -Octyl	8.68
$\text{C}_{11}\text{H}_{24}\text{O}$	<i>n</i> -Nonyl	8.13
$\text{C}_{12}\text{H}_{26}\text{O}$	<i>n</i> -Decyl	7.78
$\text{C}_{13}\text{H}_{28}\text{O}$	<i>n</i> -Undecyl	7.22

Ethyl carbinols, $\text{RC}_2\text{H}_5\text{CHOH}$ (1622); cf. (1305)

$\text{C}_4\text{H}_{10}\text{O}$	Methyl	13.87
$\text{C}_6\text{H}_{14}\text{O}$	Propyl	1.97
$\text{C}_7\text{H}_{16}\text{O}$	Butyl	8.13
$\text{C}_8\text{H}_{18}\text{O}$	Amyl	8.22
$\text{C}_9\text{H}_{20}\text{O}$	Hexyl	7.38
$\text{C}_{10}\text{H}_{22}\text{O}$	Heptyl	6.68
$\text{C}_{11}\text{H}_{24}\text{O}$	Octyl	6.25
$\text{C}_{12}\text{H}_{26}\text{O}$	Nonyl	5.97
$\text{C}_{13}\text{H}_{28}\text{O}$	Decyl	6.23
$\text{C}_{14}\text{H}_{30}\text{O}$	Undecyl	5.87
$\text{C}_{15}\text{H}_{32}\text{O}$	Dodecyl	5.53
$\text{C}_{16}\text{H}_{34}\text{O}$	Tridecyl	5.11
$\text{C}_{18}\text{H}_{38}\text{O}$	Pentadecyl	4.77

Isopropyl carbinols, $\text{RC}_3\text{H}_7\text{CHOH}$ (1305, 1620)

$\text{C}_5\text{H}_{12}\text{O}$	Methyl	4.85
$\text{C}_6\text{H}_{14}\text{O}$	Ethyl	15.06
$\text{C}_7\text{H}_{16}\text{O}$	<i>n</i> -Propyl	21.25

Isopropyl carbinols.—(Continued)

Formula	R	$[\alpha]_D^{20}$
$\text{C}_8\text{H}_{18}\text{O}$	<i>n</i> -Butyl	25.64
$\text{C}_9\text{H}_{20}\text{O}$	<i>n</i> -Amyl	22.84
$\text{C}_{10}\text{H}_{22}\text{O}$	<i>n</i> -Hexyl	21.46
$\text{C}_{12}\text{H}_{26}\text{O}$	<i>n</i> -Octyl	18.55
$\text{C}_{14}\text{H}_{30}\text{O}$	<i>n</i> -Decyl	16.15

Other carbinols (1624); cf. (1305)

Formula	Name	$[\alpha]_D^{20}$
$\text{C}_6\text{H}_{14}\text{O}$	<i>d</i> -Methyl <i>tert</i> .-butyl	7.71
$\text{C}_8\text{H}_{10}\text{O}$	<i>d</i> -Methyl phenyl	41.77
$\text{C}_9\text{H}_{12}\text{O}$	<i>l</i> -Ethyl phenyl	-25.86
$\text{C}_9\text{H}_{12}\text{O}$	<i>d</i> -Methyl benzyl	26.55
$\text{C}_{10}\text{H}_{14}\text{O}$	<i>l</i> -Methyl β -phenylethyl	-14.74
$\text{C}_{12}\text{H}_{12}\text{O}$	<i>l</i> -Methyl α -naphthyl	-14.53
$\text{C}_{17}\text{H}_{22}\text{O}$	<i>d</i> - <i>n</i> -Hexyl α -naphthyl	-1.51

Ethers of *d*-Benzylmethyl carbinol, $\text{C}_7\text{H}_7(\text{CH}_3)\text{CHOR}$ (1617)

Formula	R	$[\alpha]_D^{20}$
$\text{C}_{14}\text{H}_{22}\text{O}$	<i>n</i> -Amyl	22.75
$\text{C}_{16}\text{H}_{24}\text{O}$	<i>n</i> -Hexyl	22.83
$\text{C}_{18}\text{H}_{30}\text{O}$	<i>n</i> -Nonyl	20.78

Methyl alkyl carbonyl esters (1623, 1625)

d- β -Butyl derivatives

Formula	Ester	$[\alpha]_D^{20}$
$\text{C}_6\text{H}_{10}\text{O}_2$	Formate	18.74
$\text{C}_6\text{H}_{12}\text{O}_2$	Acetate	25.43
$\text{C}_7\text{H}_{14}\text{O}_2$	Propionate	23.85
$\text{C}_8\text{H}_{16}\text{O}_2$	<i>n</i> -Butyrate	21.97
$\text{C}_9\text{H}_{18}\text{O}_2$	<i>n</i> -Valerate	20.72
$\text{C}_{10}\text{H}_{20}\text{O}_2$	<i>n</i> -Hexoate	18.66
$\text{C}_{11}\text{H}_{22}\text{O}_2$	<i>n</i> -Heptoate	17.37

d-β-Butyl derivatives.—(Continued)

Formula	Ester	$[\alpha]_D^{20}$
C ₁₂ H ₂₄ O ₂	<i>n</i> -Octoate	16.14
C ₁₃ H ₂₆ O ₂	<i>n</i> -Nonoate	15.03
C ₁₆ H ₃₀ O ₂	<i>n</i> -Undecoate	13.42
C ₁₆ H ₃₂ O ₂	<i>n</i> -Dodecoate	12.69
C ₁₈ H ₃₆ O ₂	<i>n</i> -Myristate	11.34
C ₂₀ H ₄₀ O ₂	Palmitate	10.25
C ₂₂ H ₄₄ O ₂	Stearate	9.39

d-β-Amyl derivatives

C ₇ H ₁₄ O ₂	Acetate	17.16
C ₈ H ₁₆ O ₂	Propionate	16.43
C ₉ H ₁₈ O ₂	<i>n</i> -Butyrate	15.77
C ₁₀ H ₂₀ O ₂	<i>n</i> -Valerate	16.01
C ₁₇ H ₃₄ O ₂	<i>n</i> -Dodecoate	10.44

d-β-Hexyl derivatives

C ₈ H ₁₆ O ₂	Acetate	10.13
C ₉ H ₁₈ O ₂	Propionate	9.76
C ₁₀ H ₂₀ O ₂	<i>n</i> -Butyrate	10.83
C ₁₁ H ₂₂ O ₂	<i>n</i> -Valerate	11.16
C ₁₂ H ₂₄ O ₂	<i>n</i> -Hexoate	10.84
C ₁₃ H ₂₆ O ₂	<i>n</i> -Heptoate	10.36
C ₁₅ H ₃₀ O ₂	<i>n</i> -Nonoate	9.38
C ₁₇ H ₃₄ O ₂	<i>n</i> -Undecoate	8.35
C ₁₈ H ₃₆ O ₂	<i>n</i> -Dodecoate	7.99
C ₂₀ H ₄₀ O ₂	<i>n</i> -Myristate	7.40
C ₂₂ H ₄₄ O ₂	Palmitate	6.87
C ₂₄ H ₄₈ O ₂	Stearate	6.16

d-β-Heptyl derivatives

C ₉ H ₁₈ O ₂	Acetate	8.23
C ₁₀ H ₂₀ O ₂	Propionate	8.37
C ₁₁ H ₂₂ O ₂	<i>n</i> -Butyrate	10.16
C ₁₂ H ₂₄ O ₂	<i>n</i> -Valerate	10.26
C ₁₃ H ₂₆ O ₂	<i>n</i> -Hexoate	9.97
C ₁₄ H ₂₈ O ₂	<i>n</i> -Heptoate	9.53
C ₁₆ H ₃₀ O ₂	<i>n</i> -Octoate	9.07
C ₁₆ H ₃₂ O ₂	<i>n</i> -Nonoate	8.70
C ₁₈ H ₃₆ O ₂	<i>n</i> -Undecoate	7.96
C ₁₉ H ₃₈ O ₂	<i>n</i> -Dodecoate	7.58
C ₂₁ H ₄₂ O ₂	<i>n</i> -Myristate	6.91
C ₂₃ H ₄₆ O ₂	Palmitate	6.53
C ₂₆ H ₆₀ O ₂	Stearate	6.06

d-β-Octyl derivatives

C ₉ H ₁₈ O ₂	Formate	-4.16
C ₁₀ H ₂₀ O ₂	Acetate	6.84
C ₁₁ H ₂₂ O ₂	Propionate	6.98
C ₁₂ H ₂₄ O ₂	<i>n</i> -Butyrate	8.95
C ₁₃ H ₂₆ O ₂	<i>n</i> -Valerate	9.16
C ₁₄ H ₂₈ O ₂	<i>n</i> -Hexoate	8.96
C ₁₅ H ₃₀ O ₂	<i>n</i> -Heptoate	8.59
C ₁₆ H ₃₂ O ₂	<i>n</i> -Octoate	8.25
C ₁₇ H ₃₄ O ₂	<i>n</i> -Nonoate	7.96
C ₁₉ H ₃₈ O ₂	<i>n</i> -Undecoate	7.35
C ₂₀ H ₄₀ O ₂	<i>n</i> -Dodecoate	7.00
C ₂₂ H ₄₄ O ₂	<i>n</i> -Myristate	6.59
C ₂₄ H ₄₈ O ₂	Palmitate	6.14
C ₂₆ H ₆₂ O ₂	Stearate	5.71

d-β-Nonyl derivatives

C ₁₁ H ₂₂ O ₂	Acetate	6.21
C ₂₁ H ₄₂ O ₂	<i>n</i> -Dodecoate	6.71

d-β-Decyl derivatives

C ₁₂ H ₂₄ O ₂	Acetate	5.64
C ₂₂ H ₄₄ O ₂	<i>n</i> -Dodecoate	6.41

d-β-Undecyl derivatives

Formula	Ester	$[\alpha]_D^{20}$
C ₁₃ H ₂₆ O ₂	Acetate	5.27
C ₁₄ H ₂₈ O ₂	Propionate	5.15
C ₁₆ H ₃₀ O ₂	<i>n</i> -Butyrate	7.31
C ₁₆ H ₃₂ O ₂	<i>n</i> -Valerate	7.46
C ₁₇ H ₃₄ O ₂	<i>n</i> -Hexoate	7.37
C ₁₈ H ₃₆ O ₂	<i>n</i> -Heptoate	7.17
C ₂₀ H ₄₀ O ₂	<i>n</i> -Nonoate	6.81
C ₂₂ H ₄₄ O ₂	<i>n</i> -Undecoate	6.30
C ₂₃ H ₄₆ O ₂	<i>n</i> -Dodecoate	6.19
C ₂₅ H ₅₀ O ₂	<i>n</i> -Myristate	5.72

d-β-Dodecyl derivatives

C ₂₄ H ₄₈ O ₂	<i>n</i> -Dodecoate	5.99
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d-β-Tridecyl derivatives

C ₁₆ H ₃₀ O ₂	Acetate	4.63
C ₂₆ H ₅₀ O ₂	<i>n</i> -Dodecoate	5.87

d-γ-Nonyl esters (1051, 1625)

C ₁₀ H ₂₀ O ₂	Formate	-11.28
C ₁₁ H ₂₂ O ₂	Acetate	-5.21
C ₁₂ H ₂₄ O ₂	Propionate	-5.87
C ₁₃ H ₂₆ O ₂	<i>n</i> -Butyrate	-3.38
C ₁₄ H ₂₈ O ₂	Valerate	-3.12
C ₁₆ H ₃₀ O ₂	<i>n</i> -Hexoate	-2.66
C ₁₆ H ₃₂ O ₂	<i>n</i> -Heptoate	-2.36
C ₁₇ H ₃₄ O ₂	<i>n</i> -Octoate	-2.10
C ₁₈ H ₃₆ O ₂	<i>n</i> -Nonoate	-1.94
C ₁₉ H ₃₈ O ₂	<i>n</i> -Decoate	-1.90
C ₂₀ H ₄₀ O ₂	<i>n</i> -Undecoate	-1.83
C ₂₁ H ₄₂ O ₂	<i>n</i> -Dodecoate	-1.63
C ₂₃ H ₄₆ O ₂	<i>n</i> -Myristate	-1.55
C ₂₅ H ₆₀ O ₂	Palmitate	-1.49
C ₂₇ H ₆₄ O ₂	Stearate	-1.49

Acetic acid esters, CH₃COOR (1051)

Formula	R	$[\alpha]_D^{20}$
C ₈ H ₁₆ O ₂	<i>d</i> -γ-Hexyl	0.55
C ₉ H ₁₈ O ₂	<i>d</i> -γ-Heptyl	-4.68
C ₁₀ H ₂₀ O ₂	<i>d</i> -γ-Octyl	-4.30
C ₁₂ H ₂₄ O ₂	<i>l</i> -γ-Decyl	4.48
C ₁₃ H ₂₆ O ₂	<i>l</i> -γ-Undecyl	4.40
C ₁₄ H ₂₈ O ₂	<i>l</i> -γ-Dodecyl	3.68
C ₁₆ H ₃₀ O ₂	<i>l</i> -γ-Tridecyl	3.83
C ₁₆ H ₃₂ O ₂	<i>l</i> -γ-Tetradecyl	3.69
C ₁₇ H ₃₄ O ₂	<i>l</i> -γ-Pentadecyl	3.68
C ₁₈ H ₃₆ O ₂	<i>l</i> -γ-Hexadecyl	3.19
C ₂₀ H ₄₀ O ₂	<i>l</i> -γ-Octadecyl	2.98

Esters of methyl benzyl carbinol (1052.5)

Formula	Ester	$[\alpha]_D^{20}$
C ₁₁ H ₁₄ O ₂	Acetate	6.41
C ₁₂ H ₁₆ O ₂	Propionate	4.81
C ₁₃ H ₁₈ O ₂	<i>n</i> -Butyrate	8.48
C ₁₄ H ₂₀ O ₂	<i>n</i> -Valerate	10.76
C ₁₅ H ₂₂ O ₂	<i>n</i> -Hexoate	10.46
C ₁₆ H ₂₄ O ₂	<i>n</i> -Heptoate	10.69
C ₁₇ H ₂₆ O ₂	<i>n</i> -Octoate	10.67
C ₁₈ H ₂₈ O ₂	<i>n</i> -Nonoate	10.50
C ₁₉ H ₃₀ O ₂	<i>n</i> -Decoate	10.13
C ₂₀ H ₃₂ O ₂	<i>n</i> -Undecoate	9.92
C ₂₁ H ₃₄ O ₂	<i>n</i> -Dodecoate	9.66
C ₂₄ H ₃₈ O ₂	Myristate	9.22
C ₂₆ H ₄₂ O ₂	Palmitate	8.44
C ₂₈ H ₄₆ O ₂	Stearate	7.92

ALCOHOLS.—(Continued)

Esters of *d*- α -naphthyl-*n*-hexyl carbinol (1053)

Formula	Ester	$[\alpha]_D^{20}$
C ₁₉ H ₂₄ O ₂	Acetate	23.85
C ₂₀ H ₂₆ O ₂	Propionate	28.59
C ₂₁ H ₂₈ O ₂	<i>n</i> -Butyrate	27.02
C ₂₂ H ₃₀ O ₂	<i>n</i> -Valerate	22.23
C ₂₃ H ₃₂ O ₂	<i>n</i> -Hexoate	21.12
C ₂₄ H ₃₄ O ₂	<i>n</i> -Heptoate	19.63
C ₂₅ H ₃₆ O ₂	<i>n</i> -Octoate	21.13
C ₂₆ H ₃₈ O ₂	<i>n</i> -Nonoate	19.06
C ₂₇ H ₄₀ O ₂	<i>n</i> -Decoate	17.13
C ₂₈ H ₄₂ O ₂	<i>n</i> -Undecoate	16.44

Esters of benzoic acid and naphthoic acids with secondary alcohols

Benzoic acid esters (1056)

C ₁₁ H ₁₄ O ₂	<i>d</i> - β -Butyl	39.23
C ₁₃ H ₁₈ O ₂	<i>d</i> - β -Hexyl	35.38
C ₁₅ H ₂₂ O ₂	<i>d</i> - β -Octyl	33.27
C ₁₆ H ₁₆ O ₂	<i>d</i> -Benzyl methyl carbinyl	65.07
C ₁₆ H ₂₄ O ₂	<i>d</i> - γ -Nonyl	6.84
C ₁₈ H ₂₈ O ₂	<i>d</i> - β -Undeeyl	27.55

 α -Naphthoic acid esters (1056)

Formula	Ester	$[\alpha]_D^{20}$
C ₁₅ H ₁₆ O ₂	<i>d</i> - β -Butyl	28.40
C ₁₇ H ₂₀ O ₂	<i>d</i> - β -Hexyl	5.87
C ₁₈ H ₂₂ O ₂	<i>d</i> - β -Heptyl	3.99
C ₁₉ H ₂₄ O ₂	<i>d</i> - β -Octyl	1.67
C ₂₀ H ₁₈ O ₂	<i>d</i> -Benzyl methyl carbinyl	29.10
C ₂₀ H ₂₆ O ₂	<i>d</i> - γ -Nonyl	-22.23
C ₂₁ H ₂₈ O ₂	<i>d</i> - β -Deeyl	1.41
C ₂₂ H ₃₀ O ₂	<i>d</i> - β -Undeeyl	1.63

 β -Naphthoic acid esters (1056)

C ₁₆ H ₁₆ O ₂	<i>d</i> - β -Butyl	50.04
C ₁₇ H ₂₀ O ₂	<i>d</i> - β -Hexyl	57.11
C ₁₉ H ₂₄ O ₂	<i>d</i> - β -Octyl	56.25
C ₂₀ H ₁₈ O ₂	<i>d</i> -Benzyl methyl carbinyl	122.83
C ₂₀ H ₂₆ O ₂	<i>d</i> - γ -Nonyl	19.14
C ₂₂ H ₃₀ O ₂	<i>d</i> - β -Undeeyl	50.03

Formula	Name	Solvent	<i>d</i> or <i>C</i>	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₄ H ₁₀ O	<i>sec</i> -Butyl alcohol.....		0.8034	25	13.11	(2185)
C ₄ H ₁₀ S	<i>sec</i> -Butylmercaptan.....	EtOH	20		>12.45	(631)
C ₁₃ H ₁₃ NO	<i>l</i> - α -[β -Hydroxy- β -phenylethyl] pyridine..... NC ₆ H ₄ .CH ₂ .CHOH.C ₆ H ₅	CHCl ₃	13.2	25	-36.44	(1267)
C ₁₇ H ₂₂ O ₂	<i>d</i> - β -Octyl β -phenylpropionate.....				35.08	(908)
		CHCl ₃	2.5	22	30.88	
		C ₆ H ₆	2.5	22	35.12	
C ₁₇ H ₂₄ O ₂	<i>d</i> - β -Octyl β -cinnamate.....			22	35.32	(908)
		CHCl ₃	2.5	22	30.40	
		C ₆ H ₆	2.5	22	33.04	
C ₁₇ H ₂₆ O ₂	<i>d</i> - β -Octyl β -phenylpropionate.....			22	11.92	(908)
		CHCl ₃	2.5	22	11.52	
		C ₆ H ₆	2.5	22	6.00	
KETO ALCOHOLS						
C ₁₄ H ₁₂ O ₂	<i>d</i> -Benzoin.....	Me ₂ CO	0.413	11.5	120.5	(2214)
	<i>l</i> -Benzoin.....	Me ₂ CO	0.922	10.5	-118.6	(1354)
	<i>l</i> -Benzoin.....	EtOH	0.923	10.5	-118.6	(2214)
C ₁₄ H ₁₃ NO ₂	<i>l</i> -Benzoin α -oxime.....	CHCl ₃	0.858	24	-3.2	(2214)
		EtOH	0.965	23	4.4	
		C ₆ H ₅ CO ₂ Et	0.472	23.3	37.0	
		Me ₂ CO	0.707	15	18.0	
C ₁₅ H ₁₄ O ₂	<i>l</i> -Benzoin methyl ether.....	EtOH	0.586	11	-94.3	(2214)
		CHCl ₃	2.111	12	-88.2	
		C ₇ H ₁₆	5.65	11.5	147.8	
		C ₆ H ₆	0.643	15	50.9	
C ₁₅ H ₁₄ O ₂	<i>d</i> -Benzoylbenzylcarbinol.....	Me ₂ CO	1.23	17.5	12.6	(1344)
C ₁₆ H ₁₄ O ₃	Acetyl- <i>l</i> -benzoin.....	CHCl ₃	0.724	14.5	-217.9	(2214)
C ₂₁ H ₁₇ NO ₃	Carbanilido- <i>l</i> -benzoin.....	C ₆ H ₆	0.802	18	-291.9	(2214)
	C ₆ H ₆ .CO.CH(C ₆ H ₅).O.CO.NH.C ₆ H ₅	Me ₂ CO	0.653	21	-214.8	
POLYHYDROXY ALCOHOLS AND DERIVATIVES						
C ₆ H ₁₁ NO ₄	Pentane-3, 4, 5-triolal oxime(Class IB ₂)..... (HO.CH ₂ (CHOH) ₂ .CH ₂ .CH:NOH)	H ₂ O	4.2		10.6	(1067)
	Pentane-1, 4, 5-triol-3-one oxime..... (HO.CH ₂ .CHOH.C(NO ₂)CH ₂ .CH ₂ .OH)	H ₂ O	3.28		11.8	(1067)
C ₂₀ H ₁₈ O ₂	<i>d</i> - α , β -Dihydroxy- α , β , β -triphenylethane....	CHCl ₃	1.32		-228	(1338)
C ₂₁ H ₂₀ O ₂	<i>l</i> - β -Hydroxy- α -methoxy- α , β , β -triphenyl- ethane.....					
		Me ₂ CO	5.428	12	-185.3	(1355)
		CHCl ₃	4.579	13	-235	
		C ₆ H ₆	3.667	9	-294.5	
		EtOH	1.0176	8	-166.3	
C ₂₆ H ₂₆ O ₆	Cubebin (C ₆ H ₈ (OH) ₂ (C ₆ H ₄ :O ₂ :CH ₂) ₂).....	CHCl ₃		25	-45.45	(1366)

AMINES
MONOAMINES
sec.-Butylamine and derivatives

Formula	Name	Solvent	<i>d</i> or <i>C</i>	<i>t</i> , °C	[α] _D	Lit.
C ₄ H ₁₁ N	<i>d</i> - <i>sec</i> .-Butylamine.		0.724	20	7.44	(2014)
C ₄ H ₁₂ ClN	<i>d</i> - <i>sec</i> .-Butylamine hydrochloride.	H ₂ O	14.03	20	-1.13	(2014)
	<i>l</i> - <i>sec</i> .-Butylamine hydrochloride.	H ₂ O	13.5	20	+1.12	(2014)
C ₅ H ₁₂ N ₂ S	<i>d</i> - <i>sec</i> .-Butylthiocarbamide.		0.943	20	61.88	
C ₉ H ₂₀ N ₂ O	<i>d</i> -Di- <i>sec</i> .-butylcarbamide.	EtOH	2.46	20	39.71	(698)
<i>α-Phenylethylamine and derivatives</i>						
C ₈ H ₁₁ N	<i>d</i> -α-Phenylethylamine.		0.95	15	40.27	(1282); <i>cf.</i> (1380)
	<i>l</i> -α-Phenylethylamine.		0.952	20	-39.9	(1557); <i>cf.</i> (916)
		EtOH	3.25	20	-31.5	
C ₈ H ₁₂ ClN	<i>l</i> -α-Phenylethylamine hydrochloride.	H ₂ O	4.55	20	-5.3	(1557)
		EtOH	1.80	20	-5.0	
C ₉ H ₁₂ N ₂ O	<i>d</i> -α-Phenylethylcarbamide.	EtOH	4.035		46.2	(1380)
	<i>l</i> -α-Phenylethylcarbamide.	EtOH	14.06		-43.6	(1282)
			3.72		-52.1	
C ₉ H ₁₃ N	<i>d</i> -α- <i>p</i> -Tolylethylamine.		0.9366	20	36.57	(1985)
		EtOH	2.0	20	32.1	(1986)
		EtOH	1.0	20	32.9	
		AcOEt	2.6	20	36.1	
C ₁₀ H ₁₄ N ₂ O	<i>l</i> - <i>p</i> -Tolylethylcarbamide.	EtOH	1.53	20	-35.9	(1986)
		EtOH	0.766	20	-37.5	
		AcOEt	1.67	20	-31.3	
		AcOEt	0.835	20	-30.3	
		Me ₂ CO	1.73	20	-22.0	(1986)
C ₁₀ H ₁₅ N	<i>l</i> - <i>p</i> -Ethylphenylethylamine.			20	-31.7	(1986)
		EtOH	2.27	20	-26.0	
		AcOEt	2.00	20	-27.5	
		AcOEt	1.00	20	-28.3	
C ₁₀ H ₁₅ N	<i>N</i> -Ethyl- <i>l</i> -α-phenylethylamine		0.907	20	-61.2	(1557)
		EtOH	3.91	20	-53.2	
C ₁₀ H ₁₆ BrN	<i>N</i> -Ethyl- <i>l</i> -α-phenylethylamine hydro- bromide	H ₂ O	2.79	20	-10.3	(1557)
		EtOH	4.50	20	-17.0	
C ₁₀ H ₁₆ ClN	<i>N</i> -Ethyl- <i>l</i> -α-phenylethylamine hydro- chloride	H ₂ O	2.50	20	-12.2	(1557)
		EtOH	2.82	20	-21.4	
C ₁₁ H ₁₆ N ₂ O	<i>N</i> -Ethyl- <i>l</i> -α-phenylethylcarbamide.	EtOH	1.53	20	-50.4	(1557)
		EtOH	0.765	20	-51.5	
		AcOEt	1.66	20	-41.8	
		AcOEt	0.834	20	-42.8	
		Me ₂ CO	2.00	20	-29.2	
		Me ₂ CO	1.00	20	-30.1	
C ₁₁ H ₁₆ N ₂ S	<i>N</i> -Dimethyl- <i>l</i> -α-phenylethylthiocarbamide. . .	EtOH	2.0	20	7.1	(1986)
		AcOEt	1.53	20	31.7	
		AcOEt	0.765	20	32.8	
		Me ₂ CO	1.66	20	39.6	
C ₁₁ H ₁₇ N	<i>N</i> -Methylethyl- <i>l</i> -α-phenylethylamine.		0.904	20	-39.2	(1557)
		EtOH	2.84	20	-36.7	
C ₁₁ H ₁₇ N	<i>N</i> -Propyl- <i>l</i> -α-phenylethylamine.		0.896	20	-69.1	(1557)
		EtOH	2.76	20	-62.1	
C ₁₁ H ₁₈ BrN	<i>N</i> -Propyl- <i>l</i> -α-phenylethylamine hydro- bromide	H ₂ O	2.63	20	-20.4	
		EtOH	3.05	20	-26.3	
C ₁₁ H ₁₈ ClN	<i>N</i> -Propyl- <i>l</i> -α-phenylethylamine hydro- chloride	H ₂ O	1.90	20	-24.3	(1557)
		EtOH	1.90	20	-35.4	
C ₁₃ H ₂₀ N ₂ S	<i>N</i> -Diethyl- <i>d</i> -α-phenylethylthiocarbamide . . .	Me ₂ CO	2.0	20	-44.9	(1986)
			4.0	20	-43.9	
	<i>N</i> -Diethyl- <i>l</i> -α-phenylethylthiocarbamide. . .	EtOH	2.33	20	7.6	(1986)
		AcOEt	1.67	20	40.7	
		Me ₂ CO	1.53	20	44.1	
C ₁₅ H ₁₆ NO	Benzoyl- <i>l</i> -α-phenylethylamine.					(1986)
C ₁₅ H ₁₆ NO ₂	<i>N</i> - <i>p</i> -Hydroxybenzoyl <i>d</i> -α-phenylethylamine	CHCl ₃	0.747		54.6	(1454)
C ₁₅ H ₁₇ N	<i>N</i> -Benzyl- <i>l</i> -α-phenylethylamine.		1.008	20	-40.1	(1557)
		EtOH	3.74	20	-58.4	

AMINES.—(Continued)

Formula	Name	Solvent	<i>d</i> or <i>C</i>	<i>t</i> , °C	[α] _D	Lit.
C ₁₅ H ₁₈ ClN	<i>N</i> -Benzyl- <i>l</i> - α -phenylethylamine hydrochloride.....	H ₂ O	2.80	20	−9.1	(1557)
		EtOH	3.48	20	−18.5	
C ₁₅ H ₂₁ NO ₅	<i>l</i> -Quinie <i>l</i> - α -phenylethylamide.....	Py	6.692	20	−92.1	(1380)
C ₁₇ H ₂₁ N	<i>N</i> -Ethylbenzyl- <i>l</i> - α -phenylethylamine.....	EtOH	1.87	20	−31.5	(1557)
		EtOH	1.98	20	−12.6	
C ₁₇ H ₂₂ Cl ₂ N ₂ S	<i>d</i> -Diphenylethylthiocarbamide dihydrochloride (CS(NH.CHCH ₃ .C ₆ H ₅) ₂)	EtOH	1%		22.5	(1284)
	<i>l</i> -Diphenylethylthiocarbamide dihydrochloride	EtOH	1%		−22.1	(1284)
C ₁₈ H ₂₂ N ₂ S	Methyl- <i>l</i> -phenylethylimidophenylethylthiocarbamate (C ₆ H ₅ .CHCH ₃ .N:C(SCH ₃).NH.-CHCH ₃ .C ₆ H ₅).....	EtOH	4.15		96	(1532)
C ₁₈ H ₂₄ IN	<i>d</i> -Methylethylbenzyl- α -phenylethylammonium iodide.....	H ₂ O	4.38	20	24.9	(1557)
C ₁₈ H ₂₆ NO	<i>d</i> -Methylethylbenzyl- α -phenylethylammonium hydroxide.....	EtOH	4.54		26.0	(1557)
C ₁₈ H ₂₈ N ₂ O ₄ S	<i>d</i> - <i>p</i> -Tolyethylaniline sulfate.....	H ₂ O	3.2	20	3.4	(1986)
C ₂₀ H ₂₈ N ₂ O ₄	<i>d</i> - <i>p</i> -Tolyethylaniline oxalate.....	H ₂ O	1.5	20	4.0	(1986)
C ₂₀ H ₃₂ N ₂ O ₄ S	<i>l</i> - <i>p</i> -Ethylphenylethylamine sulfate.....	H ₂ O	3.34	20	−6.3	(1986)
		H ₂ O	1.67	20	−14.8	
		H ₂ O	0.80	20	−17.8	
		H ₂ O	0.41	20	−20.6	
C ₂₂ H ₂₃ N	<i>N</i> -Dibenzyl- <i>l</i> - α -phenylethylamine.....	EtOH	1.76	20	−97.8	(1557)
C ₂₂ H ₃₂ N ₂ O ₄	<i>l</i> - <i>p</i> -Ethylphenylethylamine oxalate.....	H ₂ O	8.67	20	−14.4	(1986)
		H ₂ O	4.34	20	−32.7	
		H ₂ O	2.17	20	−30.8	

d-Aminobenzyl- β -naphthol and derivatives (136, 138, 139, 141)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	M[_D]
R = HO.C ₁₀ H ₆ .CH(C ₆ H ₅).NH ₂						
C ₁₇ H ₁₆ NO	<i>d</i> -Aminobenzyl- β -naphthol (\equiv R).....	C ₆ H ₆	4.76	18	+58.84	
	<i>l</i> -Aminobenzyl- β -naphthol (\equiv R).....	C ₆ H ₆	5		−58.96	
C ₁₇ H ₁₆ ClNO	<i>d</i> -Aminobenzyl- β -naphthol hydrochloride....	EtOH		18	+52.89	
	<i>l</i> -Aminobenzyl- β -naphthol hydrochloride....	EtOH	4.76	18	−52.51	
C ₂₄ H ₁₇ Br ₂ NO ₂	3, 5-Dibromo-hydroxybenzylidene-R.....	C ₆ H ₆	1.29	14–15	+92.18	+471.0
C ₂₄ H ₁₇ ClN ₂ O ₃	2-Chloro-5-nitrobenzylidene-R.....	C ₆ H ₆	1.87	15–18	−98.9	−412.0
C ₂₄ H ₁₇ Cl ₂ NO	2, 5-Dichlorobenzylidene-R.....	C ₆ H ₆	0.978	15–18	−59.7	−242.6
C ₂₄ H ₁₈ BrNO ₂	3-Bromo-4-hydroxybenzylidene-R.....	C ₆ H ₆	0.885	14–15	+150.1	+648.0
C ₂₄ H ₁₈ BrNO ₂	5-Bromosalicylidene-R.....	C ₆ H ₆	1.31	14–15	−76.37	−329.9
C ₂₄ H ₁₈ ClNO	<i>o</i> -Chlorobenzylidene-R.....	C ₆ H ₆	2.90	15–18	−34.6	−128.4
	<i>m</i> -Chlorobenzylidene-R.....	C ₆ H ₆	0.995	15–18	+68.9	+255.9
	<i>p</i> -Chlorobenzylidene-R.....	C ₆ H ₆	0.932	15–18	+75.9	+282.2
C ₂₄ H ₁₈ N ₂ O ₃	<i>o</i> -Nitrobenzylidene-R.....	C ₆ H ₆	2.09	14–15	−259.36	−990.7
	<i>m</i> -Nitrobenzylidene-R.....	C ₆ H ₆	1.10	14–15	+43.88	+167.6
	<i>p</i> -Nitrobenzylidene-R.....	C ₆ H ₆	1.53	14–15	+54.29	+207.4
C ₂₄ H ₁₈ N ₂ O ₄	5-Nitrosalicylidene-R.....	C ₆ H ₆	0.187	14–15	−132.37	−526.8
	3-Nitrosalicylidene-R.....	C ₆ H ₆	0.232	14–15	+38.83	+154.5
C ₂₄ H ₁₉ NO	Benzylidene-R.....	C ₆ H ₆	4.734	20	110.7	
C ₂₄ H ₁₉ NO ₂	<i>o</i> -Hydroxybenzylidene-R.....	C ₆ H ₆	6.238	20	−15.7	
	<i>m</i> -Hydroxybenzylidene-R.....	C ₆ H ₆	0.990	15–18	+102.7	+362.6
	<i>p</i> -Hydroxybenzylidene-R.....	C ₆ H ₆	0.985	20	+297.3	+1049.5
C ₂₄ H ₁₉ NO ₃	3, 4-Dihydroxybenzylidene-R.....	C ₆ H ₆	1.105	20	+159.6	+588.8
C ₂₅ H ₁₉ NO ₃	Piperonylidene-R.....	C ₆ H ₆	2.848	20	+259.6	+989.0
C ₂₅ H ₂₀ BrNO ₂	5-Bromomethylsalicylidene-R.....	C ₆ H ₆	4.12	14–15	+39.45	+175.9
C ₂₅ H ₂₀ N ₂ O ₄	3-Nitroanisylidene-R.....	C ₆ H ₆	0.729	14–15	+135.83	+559.6
C ₂₅ H ₂₁ NO	<i>o</i> -Methylbenzylidene-R.....	C ₆ H ₆	0.906	15–18	−93.01	−326.5
	<i>m</i> -Methylbenzylidene-R.....	C ₆ H ₆	2.127	15–18	+143.73	+504.5
	<i>p</i> -Methylbenzylidene-R.....	C ₆ H ₆	2.004	15–18	+196.1	+691.4
C ₂₅ H ₂₁ NO ₂	2-Hydroxy-4-methylbenzylidene-R.....	C ₆ H ₆	3.05	15–18	−18.6	−68.3

d-Aminobenzyl-*l*-*n*-aphthol and derivatives (136, 138, 139, 141).—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	M[<i>D</i>]
C ₂₆ H ₂₁ NO ₂	<i>o</i> -Methoxybenzylidene-R.	C ₆ H ₆	6.254	20	+243.6	+894.0
	<i>m</i> -Methoxybenzylidene-R.	C ₆ H ₆	1.09	15–18	+139.7	+512.6
	<i>p</i> -Methoxybenzylidene-R.	C ₆ H ₆	7.390	20	+314.5	+1154.1
C ₂₆ H ₂₁ NO ₃	3, 4-Dihydroxy-5-methylbenzylidene-R.	C ₆ H ₆	4.096	20	+318.5	
C ₂₆ H ₁₉ ClN ₂ O ₃	α-Chloro- <i>o</i> -nitrocinnamylidene-R.	C ₆ H ₆	1.425	20	61.5	+272
C ₂₆ H ₁₉ BrN ₂ O ₃	α-Bromo- <i>p</i> -nitrocinnamylidene-R.	C ₆ H ₆	1.310	10–12	+73.8	+359.0
C ₂₆ H ₁₉ ClN ₂ O ₃	α-Chloro- <i>p</i> -nitrocinnamylidene-R.	C ₆ H ₆	1.472	10–12	+85.5	+378.0
C ₂₆ H ₂₀ BrNO	α-Bromocinnamylidene-R.	C ₆ H ₆	1.031	10–12	+146.0	+645.0
C ₂₆ H ₂₀ ClNO	α-Chlorocinnamylidene-R.	C ₆ H ₆	0.918	10–12	+199.5	+793.0
C ₂₆ H ₂₀ N ₂ O ₃	<i>o</i> -Nitrocinnamylidene-R.	C ₆ H ₆	2.380	10–12	+350.1	+1428.0
	<i>p</i> -Nitrocinnamylidene-R.	C ₆ H ₆	0.720	10–12	+395.3	+1613.0
C ₂₆ H ₂₁ NO	Cinnamylidene-R.	C ₆ H ₆	0.572	10–12	+478.0	+1775.8
C ₂₆ H ₂₃ NO ₂	2-Methoxy-4-methylbenzylidene-R.	C ₆ H ₆	2.00	15–18	+220.05	+838.4
C ₂₆ H ₂₃ NO ₃	3, 4-Dimethoxybenzylidene-R.	C ₆ H ₆	4.096	20	+318.5	+1220.0
C ₂₆ H ₂₄ N ₂ O	<i>p</i> -Dimethylaminobenzylidene-R.	C ₆ H ₆	0.994	20	+704.2	+2676.0
C ₂₇ H ₂₆ NO	<i>p</i> -Isopropylbenzylidene-R.	C ₆ H ₆	7.360	20	+197.0	+746.5
C ₂₇ H ₂₆ NO ₄	2, 4, 6-Trimethoxybenzylidene-R	C ₆ H ₆	0.869	20	+421.9	+1801.9
C ₂₈ H ₂₁ NO ₂	β-Hydroxynaphthylidene-R.	C ₆ H ₆	1.054	20	–232.3	–936.3
C ₂₉ H ₂₃ NO ₂	β-Methoxynaphthylidene-R.	C ₆ H ₆	2.585	20	+133.42	+556.4

DIAMINES

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₃ H ₉ BrN ₂	<i>d</i> -α, β-Diamino-γ-bromopropane.	H ₂ O	8.67	18	5.20	(8)
C ₃ H ₁₀ N ₂	<i>d</i> -Propylenediamine.		0.8588	25	29.70	(322)
	<i>l</i> -Propylenediamine.		0.863	25	–28.04	(322)
C ₉ H ₃₀ CoN ₆ I ₃	Cobalt tri- <i>l</i> -propylenediamine iodide.	H ₂ O	3.38	25	23.63	(323)
C ₃ H ₁₁ Br ₃ N ₂	<i>d</i> -α, β-Diamino-γ-bromopropane dihydro- bromide.	H ₂ O	7.50	18	7.27	(8)
C ₃ H ₁₂ Cl ₂ N ₂	<i>l</i> -Propylenediamine dihydrochloride.	H ₂ O	19.92	25	–4.04	(322)
C ₄ H ₁₂ N ₂ O	<i>d</i> -α, β-Diamino-γ-methoxypropane.	H ₂ O	8.31	18	8.19	(8)
C ₄ H ₁₄ Br ₂ N ₂ O	<i>d</i> -α, β-Diamino-γ-methoxypropane dihydro- bromide.	H ₂ O	8.44	18	9.04	(8)

HYDROXYAMINES

C ₉ H ₁₃ NO ₃	<i>l</i> -Adrenaline.	0.1 <i>N</i> H ₂ SO ₄	1	20	–53.3	(128)
	(C ₆ H ₃ (OH) ₂ .CHOH.CH ₂ NH.CH ₃)	CHCl ₃	9.26		–15.12	(689)
	<i>d</i> -Adrenaline.	0.32 <i>N</i> HCl	3.89	19.8	51.88	(563)
C ₂₁ H ₄₁ NO ₃	Diacetylhydroxyheptadecylamine.	50% CHCl ₃ .MeOH	18.0	25	20.44	(1220.5)

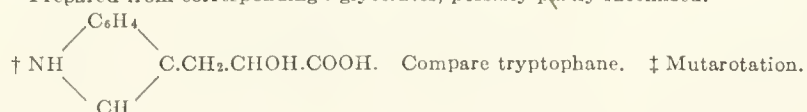
CARBOXYLIC ACIDS

MONOHALOGENOMONOCARBOXYLIC ACIDS

C ₃ H ₅ BrO ₂	<i>l</i> -α-Bromopropionic acid.		1.7084 ₂₀ ²⁰	20	–26.7	(554, 555); cf. (1764)
			1.705 ₄ ²⁰	20	–27	(1765)
C ₄ H ₇ BrO ₂	Methyl <i>d</i> -α-bromopropionate.		1.482 ₄ ¹⁷		42.65	(2102)
C ₄ H ₇ ClO ₂	<i>d</i> -β-Chlorobutyric acid.	H ₂ O	9.89	20	49.8	(545)
		PhMe	10.21	20	46.6	
	Sodium salt.	<i>N</i> NaOH	9.10	20	41.3	(545)
C ₄ H ₇ ClO ₂	Methyl <i>d</i> -α-chloropropionate.		1.1520 ₄ ²⁰		19.01	(2091)
C ₅ H ₉ BrO ₂	Ethyl <i>l</i> -α-bromopropionate.		1.386 ₄ ⁹		–31.45	(2102)
C ₅ H ₉ ClO ₂	Ethyl <i>d</i> -α-chloropropionate.		1.0888 ₄ ²⁰		12.86	(2091)
C ₆ H ₁₁ BrO ₂	<i>l</i> -α-Bromoisohexic acid.		1.358	20	–49.43	(495)
C ₆ H ₁₁ BrO ₂	Propyl <i>d</i> -α-bromopropionate.		1.315 ₄ ¹⁴		–21.98	(2102)
C ₆ H ₁₁ ClO ₂	Propyl <i>d</i> -α-chloropropionate.		1.065 ₄ ⁶		11.0	(2102)
C ₈ H ₇ BrO ₂	<i>l</i> -Phenylbromoacetic acid.	C ₆ H ₆	4.10		–147.5	(1349); cf. (2090)
C ₈ H ₇ ClO ₂	<i>l</i> -Phenylchloroacetic acid.	C ₆ H ₆	3.345	12	–191	(1332, 1333)
		CHCl ₃	1.650	11.2	–159.4	
		EtOH	2.00	18	–155.8	(1346); cf. (2090)
C ₈ H ₁₅ BrO ₂	Ethyl <i>l</i> -α-bromoisocaproate.		1.22	20	–43.1	(1867)
C ₉ H ₉ BrO ₂	<i>l</i> -α-Bromohydrocinnamic acid.		1.48	20	–8.3	(495)
C ₉ H ₉ ClO ₂	Methyl <i>l</i> -phenylchloroacetate.		1.213	15	–86.7	(1330)
C ₁₀ H ₁₁ ClO ₂	Ethyl <i>l</i> -phenylchloroacetate.		1.162	16.4	–64.0	(1330)
C ₁₁ H ₁₃ ClO ₂	<i>d</i> -Isopropylphenylchloroacetic acid.	C ₆ H ₆	3.0		23.3	(2090)

DIHALOGENOMONOCARBOXYLIC ACIDS AND THEIR DERIVATIVES

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₃ H ₄ Br ₂ O ₂	<i>d</i> -α, β-Dibromopropionic acid.....	H ₂ O	4.94	18	13.76	(6)
C ₄ H ₆ Cl ₂ O ₂	Methyl α, β-dichloropropionate*.....	EtOH	7.45	18	6.42	(658)
C ₆ H ₅ Br ₂ O ₂	Ethyl <i>d</i> -α, β-dibromopropionate.....	EtOH	1.08	18	9.77	(6)
C ₆ H ₅ Cl ₂ O ₂	Ethyl α, β-dichloropropionate*.....			20	-1.79	(658)
C ₇ H ₁₂ Cl ₂ O ₂	Isobutyl α, β-dichloropropionate*.....			20	-3.62	(658)
C ₁₀ H ₁₈ Cl ₂ O ₂	Heptyl α, β-dichloropropionate*.....			20	-1.73	(658)
MONOHYDROXYMONOCARBOXYLIC ACIDS						
C ₃ H ₅ O ₃ K	Potassium <i>d</i> -glycidate.....	H ₂ O	6.50	18	30.16	(6)
<i>Lactic acid and derivatives (including thio-compounds)</i>						
C ₃ H ₆ O ₂ S	<i>l</i> -Thiolaetic acid.....		1.193 ^{19.2} _{19.2}	15	-45.47	(1283)
C ₃ H ₆ O ₃	<i>d</i> -Lactic acid (CH ₃ .CHOH.COOH).....	H ₂ O	10.46	15	3.82	(1019); cf.
		H ₂ O	5.022	15	3.33	(924,
		H ₂ O	2.511	15	2.67	2201)
		H ₂ O	1.527	15	2.61	
	Calcium salt.....	H ₂ O	7.23		-3.87	(2201)
	Lithium salt.....	H ₂ O	5		-10.95	(924)
		H ₂ O	12		-12.28	(1019); cf.
	Zinc salt + 2H ₂ O.....	H ₂ O	5.0	15	-6.0	(924,
		H ₂ O	2.5	15	-8.0	2201)
		H ₂ O	1.25	15	-11.1	
		H ₂ O	0.512	15	-13.35	
C ₄ H ₈ O ₃	<i>l</i> -Methoxypropionic acid.....	H ₂ O	13.47		-71.09	(1737)
	Calcium salt.....	H ₂ O	9.53		-38.09	(1737)
	Sodium salt.....	H ₂ O	16.53		-49.43	(1737)
C ₆ H ₁₀ O ₃	Ethyl <i>l</i> -lactate; cf. (646, 1095).....		1.030	19	14.52	(2102)
C ₆ H ₁₀ O ₃	<i>d</i> -Ethoxypropionic acid.....	H ₂ O	29.37		56.96	(1737)
	Calcium salt.....	H ₂ O	26.87		38.40	(1737)
	Sodium salt.....	H ₂ O	17.96		48.09	(1737)
C ₆ H ₈ O ₄	<i>d</i> -Lactide.....	C ₆ H ₆	1.167	18	-298	(1020)
		C ₆ H ₆	0.583	18	-280	
		C ₆ H ₆	0.292	18	-246	
		H ₂ O	0.39		-8‡	
C ₆ H ₁₀ O ₄ S	<i>l</i> -Thiodilactylic acid (S(CH ₂ .CH ₂ .COOH) ₂)..	H ₂ O			-190	(1283)
C ₆ H ₁₀ O ₄ S ₂	<i>d</i> -Dithiodilactylic acid (S ₂ (CH ₂ .CH ₂ .COOH) ₂)	H ₂ O	6.4	15	429	(1283)
C ₆ H ₁₂ O ₃	Propyl <i>d</i> -lactate.....		1.004	19	-17.06	(2102)
C ₆ H ₁₂ O ₃	<i>d</i> -Propoxypropionic acid.....	H ₂ O	11.45		55.63	(1737)
	Calcium salt.....	H ₂ O	12.01		48.54	(1737)
	Sodium salt.....	H ₂ O	30.75		48.94	(1737)
C ₉ H ₉ NO ₅	<i>l</i> - <i>m</i> -Nitrophenoxypionic acid.....	EtOH	0.8	21	-51.87	(617)
	<i>l</i> - <i>p</i> -Nitrophenoxypionic acid.....	EtOH	0.8	21	-53.7	
C ₁₁ H ₁₁ NO ₃	<i>l</i> -Indol-3-lactic acid†.....	H ₂ O	1.391	20	-5.34	(411)
<i>β-Hydroxybutyric acid and salts</i>						
C ₄ H ₈ O ₃	<i>l</i> -β-Hydroxybutyric acid.....	H ₂ O	3.26	20	-24.8	(1325); cf. (374.5, 775, 1138.5, 1440.5, 1838.6)
		EtOH	8.21	18	-17.5	
	Magnesium salt.....	H ₂ O	14.39	13	-17.9	
		H ₂ O	2.30	13	-15.3	
	Potassium salt.....	H ₂ O	4.37	12	-12.3	
		H ₂ O	1.75	12	-11.9	
	Sodium salt.....	H ₂ O	8.52	15	-14.5	
		H ₂ O	1.36	17	-13.8	
	Zinc salt.....	H ₂ O	22.21	18	-17.9	
		H ₂ O	1.42	18	-14.2	
C ₄ H ₅ Cl ₃ O ₃	<i>l</i> -γ, γ, γ-Trichloro-β-hydroxybutyric acid....	EtOH	1.553	17	-29.6	(1345)
		EtOH	4.000	15.5	-30.1	
		Me ₂ CO	1.553	16.5	-22.5	
<i>Mandelic acid and derivatives</i>						
C ₈ H ₈ O ₃	<i>d</i> -Mandelic acid (C ₆ H ₅ .CHOH.COOH); cf. (1242, 1324.5, 1783.5, 2090, 2091)	H ₂ O	2.01		155.5	(404)

* Prepared from corresponding *l*-glycerates, possibly partly racemized.

Mandelic acid and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>c</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₈ H ₈ O ₃	<i>l</i> -Mandelic acid.....	H ₂ O	1.56		-157.4	(1698)
C ₈ H ₉ NO ₂	<i>l</i> -Mandelamide.....	Me ₂ CO	1.65		-73.1	(2214)
	<i>d</i> -Mandelamide.....	Me ₂ CO	1.65	9	74.7	
C ₈ H ₁₄ O ₃	<i>d</i> -Hexahydromandelic acid.....	AcOH	10	23	-26.6*	(667)
		AcOH	10	27	-25.8*	
C ₈ H ₁₅ NO ₂	<i>d</i> -Hexahydromandelic amide.....	20% EtOH	1.26	25	47.4*	(667)
C ₉ H ₁₀ O ₃	Methyl <i>l</i> -mandelate.....	CS ₂	3.33	22	-214.1	(2090)
		CS ₂	1.67	22	-217.0	
		Me ₂ CO	3.33	22	-110.2	
C ₉ H ₁₀ O ₃	<i>l</i> -Methoxyphenylacetic acid.....	EtOH	6.7656	13.5	-150.0	(1355)
C ₉ H ₁₀ O ₄	<i>d-p</i> -Methoxymandelic acid.....	H ₂ O	2.5	19	146.14	(1103)
C ₉ H ₁₁ NO ₂	<i>l-α</i> -Methoxyphenylacetamide.....	Me ₂ CO	3.457	18	-103.6	(1355)
C ₉ H ₁₆ O ₃	Methyl <i>d</i> -hexahydromandelate.....		1.066	25	-4.7*	
C ₁₀ H ₁₀ O ₄	<i>l</i> -Acetylmandelic acid.....	EtOH	2.22		-157.7	(1341)
		Me ₂ CO	2.08		-153.7	
C ₁₀ H ₁₂ O ₃	Ethyl <i>l</i> -mandelate.....	CHCl ₃	6.67	22	-128.4	(2090)
		Me ₂ CO	5.81	22	-90.62	
		CS ₂	5.00	22	-180.0	
C ₁₀ H ₁₃ NO ₂	<i>l</i> -Mandeloethylamide.....	EtOH	3.693	16	-34.4	(1344)
C ₁₁ H ₁₂ O ₄	Methyl <i>l</i> -acetylmandelate.....		1.1546		-146.37	(2090); <i>cf.</i> (2100)
C ₁₂ H ₁₄ O ₄	Methyl <i>l</i> -propionylmandelate.....		1.1261		-135.5	(2090)
C ₁₂ H ₁₆ O ₃	Isobutyl <i>l</i> -mandelate.....	CS ₂	5		-146.6	(2090); <i>cf.</i> (2100)
C ₁₃ H ₁₆ O ₄	Ethyl <i>l</i> -propionylmandelate.....		1.0936		-113.7	(2090)
		CHCl ₃	10.0		-110.8	
C ₁₃ H ₁₈ O ₃	<i>dl</i> -Amyl <i>l</i> -mandelate.....		1.0531		-96.46	(2090)
	<i>l</i> -Amyl <i>l</i> -mandelate.....		1.0530		-94.02	
C ₁₅ H ₂₀ O ₄	Ethyl <i>l</i> -valerylmandelate.....		1.0544		-97.06	(2090)
C ₁₇ H ₁₉ NO ₃	<i>l</i> -Hydrindamine <i>d</i> -mandelate.....	EtOH	3.73		-55	(1073)
	<i>d</i> -Hydrindamine <i>l</i> -mandelate.....	EtOH	3.37		57	
	<i>d</i> -Hydrindamine <i>d</i> -mandelate.....	EtOH	3.97		53.7	
C ₂₀ H ₂₈ O ₄	<i>l</i> -Menthyl <i>l</i> -acetylmandelate.....	EtOH	2.58		-123.1	(1341); <i>cf.</i> (2090)
	<i>l</i> -Menthyl <i>d</i> -acetylmandelate.....	EtOH	2.68		8.8	
	<i>l</i> -Menthyl <i>dl</i> -acetylmandelate.....	EtOH	2.53		-57.2	
<i>Homologues of mandelic acid</i>						
C ₉ H ₁₀ O ₃	<i>d-α</i> -Hydroxy-β-phenylpropionic acid.....	H ₂ O	2.56	13.5	22.8	(1356)
		EtOH	3.53	12	18.5	
	<i>d-β</i> -Hydroxy-β-phenylpropionic acid.....	EtOH	5.194	10.5	19.2	(1342)
	<i>l-β</i> -Hydroxy-β-phenylpropionic acid.....	EtOH	5.15	20	-18.9	(1342)
C ₉ H ₁₀ O ₄	<i>d-α</i> -Hydroxy-β- <i>p</i> -hydroxyphenylpropionic acid.....	H ₂ O	1.13	20	18.14	(411)
C ₉ H ₁₁ NO ₂	<i>d-α</i> -Hydroxy-β-phenylpropionamide.....	EtOH	2.076	20	81.4	(1344)
	<i>d-β</i> -Hydroxy-β-phenylpropionamide.....	EtOH	4.43	13	38.4	(1344)
C ₁₁ H ₁₄ O ₃	<i>l</i> -Isopropylphenylglycolic acid.....	EtOH	4.09	17	-135	(452, 453)
C ₁₁ H ₁₄ O ₃	Ethyl <i>l-β</i> -hydroxy-β-phenylpropionate.....	EtOH	4.72	20	-14.1	(1342)
		H ₂ O	2.16	20	22.22	(411)
C ₁₁ H ₁₅ NO ₂	<i>l-β</i> -Hydroxy-β-phenylpropionethylamide...	EtOH	3.99	15.5	-26.2	(1344)
<i>Other hydroxy monocarboxylic acids and derivatives</i>						
C ₆ H ₁₂ O ₃	<i>l</i> -Leucic acid ((CH ₃) ₂ CHCH ₂ CH(OH).COOH)	H ₂ O	9.854	20	-10.4	(1867)
	Sodium salt.....	H ₂ O	9.828†	20	-27.8	(1867)
C ₈ H ₁₆ O ₃	Ethyl <i>l</i> -leucate.....		0.965	20	-11.07	(1867)
C ₁₅ H ₃₀ O ₃	Convolvulinic acid (C ₁₄ H ₂₈ (OH).COOH)...	CHCl ₃	20.869		1.39	(1705); <i>cf.</i> (1702)
C ₁₆ H ₃₂ O ₃	Methyl convolvulinolate.....	CHCl ₃	10.07		1.57	(1705)
C ₁₆ H ₃₂ O ₃	Hydroxyhexadecylic or jalapinic acid (C ₁₅ H ₃₀ (OH).COOH).....	CHCl ₃	17.76		0.79	(1705)
C ₁₇ H ₃₄ O ₃	Methyl hydroxyhexadecylate.....	CHCl ₃	14.38		0.98	(1705)
		CHCl ₃	18.63		0.94	(1760)
C ₁₈ H ₃₂ O ₃	Ricinostearolic acid (C ₁₇ H ₃₀ (OH).COOH)...	Me ₂ CO	6.4		13.67	(2088)
C ₁₈ H ₃₄ O ₃	Ricinoleic acid (CH ₃ .(CH ₂) ₅ .CHOH.CH:CH(CH ₂) ₈ .COOH)	Me ₂ CO	4.8-21	22	6.25-7.5	(2088)

* $\lambda = 5461$. † Mutarotation.

Other hydroxymonocarboxylic acids and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₈ H ₃₄ O ₃	Ricinelaic acid.....	Me ₂ CO	5		4.8	(2088)
		EtOH	12		6.67	
C ₁₉ H ₃₆ O ₃	Methyl ricinoleate.....		0.927	15	5.20	(798)
C ₂₀ H ₃₈ O ₃	Ethyl ricinoleate.....		0.918	15	4.48	(798)
C ₂₁ H ₄₀ O ₃	<i>n</i> -Propyl ricinoleate.....		0.912	15	4.35	(798)
C ₂₂ H ₄₂ O ₃	Isobutyl ricinoleate.....		0.908	15	4.22	(798)
C ₂₅ H ₅₀ O ₃	Cerebronic acid (C ₂₃ H ₄₇ .CHOH.COOH)....	EtOH	6.0	20	3.55	(1239)
DIHYDROXYMONOCARBOXYLIC ACIDS						
Glyceric acid and derivatives (including thio-compounds)						
C ₃ H ₆ O ₄	<i>d</i> -Glyceric acid: Barium salt.....	H ₂ O	9.89	20	−10.93	(638)
		H ₂ O	7.70		−17.38	(1509); <i>cf.</i> (632, 640, 649, 1243, 1510)
C ₃ H ₆ O ₄	<i>l</i> -Glyceric acid.....	H ₂ O	9.53	20	12.94	(517)
C ₃ H ₇ NO ₃	Glycerylamide.....		1.3347	100	−39.98	(664)
			1.3048	136	−38.11	
		MeOH	2.439	20	−63.09	
C ₄ H ₈ O ₄	Methyl <i>d</i> -glycerate.....		1.2798	15	−4.80	(649); <i>cf.</i>
C ₆ H ₁₀ O ₄	Ethyl <i>d</i> -glycerate.....		1.1921	15	−9.18	(633, 655)
C ₆ H ₁₁ NO ₃	α, β-Dimethoxypropionamide.....	MeOH	3.13	20	−54.55	(642)
		Py	1.696	20	−71.60	
C ₆ H ₁₀ O ₆ S ₂	β-Dithio-α-hydroxypropionic acid ([S.CH ₂ .CH(OH).COOH] ₂).....	H ₂ O	3.21		−10.6	(1501)
	Barium salt.....	H ₂ O	5.08	22	−19.08	(1501)
C ₆ H ₁₂ O ₄	<i>n</i> -Propyl <i>d</i> -glycerate.....		1.1448	17	−12.94	(649); <i>cf.</i> (633, 655)
C ₆ H ₁₂ O ₄	Isopropyl <i>d</i> -glycerate.....		1.1303	15	−11.82	(649)
C ₆ H ₁₂ O ₄	Methyl α, β-dimethoxypropionate.....		1.0634	20	−69.70	(642)
C ₆ H ₁₃ NO ₃	α, β-Dimethoxypropionic methylamide.....	MeOH	1.892	20	−58.72	(642)
C ₇ H ₁₄ O ₄	<i>n</i> -Butyl <i>d</i> -glycerate.....		1.1084	17	−13.19	(649); <i>cf.</i> (633, 655)
	Isobutyl <i>d</i> -glycerate.....		1.1051	18	−14.23	
	<i>sec</i> -Butyl <i>d</i> -glycerate.....		1.1052	19	−10.58	
C ₇ H ₁₄ O ₄	Ethyl α, β-dimethoxypropionate.....		1.0309	20	−69.95	(642)
C ₈ H ₁₆ O ₄	Propyl α, β-dimethoxypropionate.....		1.0090	20	−69.01	(642)
C ₉ H ₁₈ O ₄	Butyl α, β-dimethoxypropionate.....		0.9921	20	−64.88	(642)
C ₉ H ₁₁ NO ₃	Glycerylanilide.....		1.2084	100	−39.98	(664)
			1.1752	139	−36.16	
		MeOH	2.44	20	−72.13	
		MeOH	5.66	20	−67.29	
C ₁₀ H ₁₃ NO ₃	Glyceryl- <i>o</i> -toluidide.....	MeOH	2.44	20	−32.55	(664)
		MeOH	5.66	20	−37.18	
	Glyceryl- <i>p</i> -toluidide.....	MeOH	2.44	20	−63.97	
			1.2121	98	−34.69	
			1.1376	179	−29.62	
C ₁₀ H ₂₀ O ₄	Heptyl <i>d</i> -glycerate.....		1.0390	18	−11.30	(649); <i>cf.</i> (633, 655)
C ₁₁ H ₂₂ O ₄	Octyl <i>d</i> -glycerate.....		1.0263	19	−10.22	
C ₁₂ H ₂₄ O ₄	Heptyl α, β-dimethoxypropionate.....		0.9571	20	−54.84	(642)
C ₁₃ H ₂₆ O ₄	Octyl α, β-dimethoxypropionate.....		0.9527	20	−50.46	(642)

SIMPLE DICARBOXYLIC ACIDS

Phenylsuccinic acid and derivatives (2217)

Formula	Name	Solvent	<i>C</i>	<i>t</i> , °C	[α] _D	
C ₁₀ H ₁₀ O ₄	α-Phenylsuccinic acid.....	Me ₂ CO	1.802	15.4	173.4	
		EtOH	1.534	16.5	148.3	
		AcOEt	1.550	15.5	174.2	
	<i>l</i> -Phenylsuccinic acid.....	Me ₂ CO	1.483	14.5	−173.3	
		MeOH	1.941	12.5	−147.1	
C ₁₂ H ₁₄ O ₄	Dimethyl <i>d</i> -phenylsuccinate.....	Me ₂ CO	1.723	10	142.2	
		C ₆ H ₆	1.443	15	159.0	
		CCl ₄	1.272	15	169.8	
		EtOH	1.558	12	140.9	
		AcOEt	1.267	11.5	150.7	

Phenylsuccinic acid and derivatives (2217).—(Continued)

Formula	Name	Solvent	<i>C</i>	<i>t</i> , °C	$[\alpha]_D$	
C ₁₄ H ₁₈ O ₄	Diethyl <i>d</i> -phenylsuccinate.....	Me ₂ CO	3.090	13	103.4	
		CCl ₄	1.853	16	130.6	
		EtOH	2.242	15.5	100.8	
C ₁₀ H ₈ O ₃	<i>d</i> -Phenylsuccinic anhydride.....	C ₆ H ₆	1.298	15	100.9	
		PhMe	1.500	12.5	102.7	
		AcOEt	1.090	16	90.8	
	<i>l</i> -Phenylsuccinic anhydride.....	C ₆ H ₆	1.382	14	−100.9	
		CHCl ₃	0.954	10.5	−92.2	

d-β-Octyl alkyl esters of dicarboxylic acids (778)

Formula	Name	$[\alpha]_D^{20}$
C ₁₁ H ₂₀ O ₄	Octyl methyl oxalate	14.22
C ₁₂ H ₂₂ O ₄	Octyl ethyl oxalate	13.98
C ₁₃ H ₂₄ O ₄	Octyl ethyl malonate	9.27
C ₁₃ H ₂₄ O ₄	<i>l</i> -β-Octyl methyl succinate	−3.54
C ₁₈ H ₃₄ O ₄	Dioctyl oxalate	22.72
C ₂₂ H ₄₂ O ₄	Dioctyl adipate	11.23
C ₂₄ H ₄₆ O ₄	Dioctyl suberate	11.01
C ₂₇ H ₅₂ O ₄	Octyl <i>n</i> -nonane- <i>i</i> -dicarboxylate	10.37
C ₂₈ H ₅₄ O ₄	Octyl <i>n</i> -decane- <i>k</i> -dicarboxylate	10.36
C ₂₉ H ₅₆ O ₄	Octyl <i>n</i> -undecanedicarboxylate	9.25

Alkylisopropyl carbonyl hydrogen phthalates in 5% CHCl₃ solution (1620)

Formula	Alkyl	$[\alpha]_D^{20}$ (?)
C ₁₃ H ₁₆ O ₄	<i>d</i> -Methyl	37.9
C ₁₄ H ₁₈ O ₄	<i>d</i> -Ethyl	−0.5
C ₁₅ H ₂₀ O ₄	<i>d</i> -Propyl	7.8
C ₁₆ H ₂₂ O ₄	<i>d</i> - <i>n</i> -Butyl	13.9
C ₁₇ H ₂₄ O ₄	<i>d</i> - <i>n</i> -Amyl	13.5
C ₁₈ H ₂₆ O ₄	<i>d</i> - <i>n</i> -Hexyl	11.8
C ₂₀ H ₃₀ O ₄	<i>d</i> - <i>n</i> -Octyl	16.9
C ₂₂ H ₃₄ O ₄	<i>d</i> - <i>n</i> -Decyl	13.9

MONOHALOGENODICARBOXYLIC ACIDS

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₄ H ₃ ClO ₃	<i>d</i> -Chlorosuccinic anhydride.....	AcOEt	10		30.85	(2089)
C ₄ H ₃ Cl ₃ O ₂	<i>d</i> -Chlorosuccinyl chloride.....	AcOEt	5		33.60	(2089)
			1.5002	20	29.53	(2086)
C ₄ H ₅ BrO ₄	<i>d</i> -Bromosuccinic acid.....	Et ₂ O	4.65	20	60.5	(1238)
		H ₂ O	11.64	20	35.2	
	<i>l</i> -Bromosuccinic acid.....	Et ₂ O	5.33		−67.92	(2089, 2091)
		AcOEt	6.66		−72.7	
C ₄ H ₅ ClO ₄	<i>d</i> -Chlorosuccinic acid.....	H ₂ O	2.706	18.5	20.1	(1330)
		H ₂ O	16	21	20.6	(2086)
		H ₂ O	3.2	21	21.3	
		AcOEt	10		52.85	(2089)
C ₄ H ₅ IO ₄	<i>l</i> -Iodosuccinic acid.....	AcOEt	5.58	19	−89.8	(920.5)
		EtOH	2.95	19	−76.2	
		H ₂ O	2.67	19	−54.9	
	Sodium hydrogen salt.....	0.5 <i>N</i> H ₂ SO ₄	6.7	19	−55.1	(920.5)
		H ₂ O	6.12	19	−35.6	
		H ₂ O	5	19	−46.5	
C ₄ H ₅ BrNO ₃	<i>l</i> -Bromosuccinamic acid.....	EtOH	6.66		−67.12	(2089, 2091)
		AcOEt	6.66		−67.57	
		20% H ₂ SO ₄	3.00		−44.3	
C ₅ H ₇ ClO ₄	<i>l</i> -α-Chloroglutaric acid.....	H ₂ O	36.2	18	−12.6	(526)
C ₆ H ₉ BrO ₄	Dimethyl <i>d</i> -bromosuccinate.....				50.83	(2091)
C ₈ H ₁₃ BrO ₄	Diethyl <i>d</i> -bromosuccinate.....				40.96	(2091)
C ₈ H ₁₃ ClO ₄	Diethyl <i>d</i> -chlorosuccinate.....			20	31.33	(372)
			1.152 ^{19.5}	19.8	32.7	(1330)
C ₁₀ H ₁₇ BrO ₄	Dipropyl <i>d</i> -bromosuccinate.....		1.3010		38.05	(2089)
C ₁₆ H ₂₅ BrO ₄	α-Methyl β-menthyl bromosuccinate.....		1.181	20	−46.1	(344)
	β-Methyl α-menthyl bromosuccinate.....		1.210	20	−49.1	(344)

MONOHYDROXYDICARBOXYLIC ACIDS

Malic acid and derivatives

C ₄ H ₆ O ₅	<i>d</i> -Malic acid*.....	H ₂ O	7	19	2.33	(364)
	<i>d</i> -Malic acid, uranyl salt.....	1% UO ₄ Ac ₂	5	18	483	(364); cf. (371)
C ₄ H ₆ O ₅	<i>l</i> -Malic acid*.....	H ₂ O	20	9	−0.65	{ (331); cf. (2197)
		H ₂ O	20	45.5	−2.45	

* Anhydrous acid: (2093, 2097, 2098). In water solution (20.5, 239, 666, 756, 1162.5, 1466, 1561, 1878, 2018, 2212.5). In acetone solution (20.5, 767.5, 1486, 2092, 2093, 2096). In propyl alcohol (1486). In methyl alcohol (1486, 2093). In acetaldehyde (2096). In benzaldehyde (2098). In pyridine (756, 920, 2098). In isobutyl alcohol (2098). Influence of concentration (1486, 2212.5). Influence of temperature (756, 1486, 2212.5). Influence of boric acid (756, 1486). Influence of various solvents (756, 1486, 2098). Influence of inactive substances (331, 1362, 1878, 1989, 2096.5). Dispersion (1486, 2096). Influence of uranyl nitrate (66.5, 2095). Influence of molybdic acid and molybdates (369, 755, 990). Normal and acid salts of *l*-malic acid and K, Na, Li, NH₄, Ba (1878, 2018, 2021). Ammonium antimonyl malate (1561); Influence of *d*-malic acid (239, 240, 1648, 2093.8, 2100.8).

Malic acid and derivatives.—(Continued)

Formula	Name	Solvent	d , C or %	t , °C	$[\alpha]_D$	Lit.
$C_6H_8O_6$	<i>l</i> -Acetylmalic acid.....	H ₂ O	10.9		−10.7	(916)
	Sodium hydrogen salt.....	H ₂ O	5.18*		−1.46*	(916)
<i>Esters of malic acid</i>						
$C_5H_8O_5$	Methylene malate.....	MeOH	1		−3	(1262.5)
$C_6H_{10}O_5$	Dimethyl <i>l</i> -malate; cf. (38, 752.5, 1745).....		1.2337		−6.85	(2089)
			1.238	15	−6.80	(331,
			1.149	100	−7.31	370); cf.
		H ₂ O	9.73	12	−11.07	(1590,
		H ₂ O	9.73	50	−9.64	2089)
			1.1294	20	−10.18	(2089)
$C_8H_{14}O_5$	Diethyl <i>l</i> -malate; cf. (38, 1590, 1745).....					(2089);
$C_{10}H_{18}O_5$	Dipropyl <i>l</i> -malate.....		1.0745	20	−11.62	cf. (38,
	Diisopropyl malate.....		1.0760	20	−10.41	1745,
$C_{12}H_{22}O_5$	Di- <i>n</i> -butyl <i>l</i> -malate.....		1.0382	20	−10.72	(38, 1745)
			1.0418	20	−11.14	(2089); cf.
	Diisobutyl malate.....					(2100)
				20	−10.26	(1587)
			9.45		−11.8	
			10.21		−12.6	
			10.09		−12.3	
			10.64		−10.3	
			10.66		−10.4	
			10.21		−10.8	
			8.52		−11.0	
			3.60		2.3	
$C_{14}H_{26}O_5$	Di- <i>dl</i> -amyl malate.....		1.079	20	−9.92	(2089)
$C_{14}H_{26}O_5$	Di- <i>l</i> -amyl malate.....		1.0176	20	−6.88	(2089)
$C_{20}H_{38}O_5$	Dioctyl malate†.....		0.9761	20	−6.92	(2089)
<i>Esters of nitromalic acid</i>						
$C_6H_9NO_7$	Dimethyl nitromalate.....	CHCl ₃	1.318	20	−33.01	(2099)
			4.0	20	−18.80	(2089)
$C_8H_{13}NO_7$	Diethyl nitromalate.....		1.2090	20	−31.24	(2099)
$C_{10}H_{17}NO_7$	Di- <i>n</i> -propyl nitromalate.....		1.1932	20	−25.65	(2099)
<i>Esters of acylmalic acids</i>						
$C_8H_{11}BrO_6$	Dimethyl bromoacetyl- <i>l</i> -malate.....		1.5072	20	−22.40	(2089)
$C_8H_{11}ClO_6$	Dimethyl chloroacetyl- <i>l</i> -malate.....		1.3062	20	−23.30	(2089)
$C_8H_{12}O_6$	Dimethyl acetyl- <i>l</i> -malate.....		1.1975	20	−22.92	(2089); cf.
$C_{10}H_{16}O_6$	Diethyl acetyl- <i>l</i> -malate; cf. (38, 1590, 1745, 2089, 2100)		1.1169	20	−22.6	(1773)
$C_9H_{14}O_6$	Dimethyl propionyl- <i>l</i> -malate.....		1.1609	20	−22.94	(2089); cf.
$C_{10}H_{15}BrO_6$	Diethyl bromoacetyl- <i>l</i> -malate.....		1.3936	20	−22.48	(2089)
			1.2062	20	3.07	(2100); cf.
$C_{10}H_{15}ClO_6$	Diethyl chloroacetylmalate.....					(38, 1745)
$C_{10}H_{16}O_6$	Dimethyl <i>n</i> -butyryl- <i>l</i> -malate.....		1.1317	20	−22.44	(2089)
			1.1255	20	−22.36	
$C_{11}H_{17}BrO_6$	Diethyl α -bromopropionyl- <i>l</i> -malate.....		1.3325	20	−22.48	(2089)
$C_{11}H_{18}O_6$	Dimethyl isovaleryl- <i>l</i> -malate.....		1.1034	20	−22.39	(2089)
			1.0926	20	−22.79	(1773); cf.
$C_{12}H_{19}ClO_6$	Diethyl propionyl- <i>l</i> -malate.....					(2089,
						2100)
			1.1566	20	−23.52	(2089)
			1.3059	20	−24.76	(2089)
			1.2850	20	−22.57	(2089)
$C_{12}H_{20}O_6$	Dipropyl bromoacetyl- <i>l</i> -malate.....		1.3150	20	−22.24	(2089)
			1.0735	20	−22.75	(1773)
			1.0688	20	−21.99	(2089)
			1.0724	20	−22.85	(2089)
			1.0551	20	−21.38	(1773)
$C_{13}H_{22}O_6$	Diethyl <i>n</i> -valeryl- <i>l</i> -malate.....		1.0605	20	−22.07	(2089)

* Calculated on weight of acid. † Described by author as dicapryl malate.

Esters of acylmalic acids.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₄ H ₂₃ BrO ₆	Diisobutyl bromoacetyl- <i>l</i> -malate.....		1.2022	20	-20.38	(2089)
C ₁₄ H ₂₄ O ₆	Diethyl <i>n</i> -hexoyl- <i>l</i> -malate.....		1.0420	20	-20.30	(1773)
	Dipropyl <i>n</i> -butyryl- <i>l</i> -malate.....		1.0417	20	-22.40	(2089); <i>cf.</i> (2100)
	Di- <i>n</i> -butyl acetyl- <i>l</i> -malate.....		1.0430	20	-19.93	(38); <i>cf.</i> (1745)
	Diisobutyl acetyl- <i>l</i> -malate.....		1.0362	20	-21.88	(2089); <i>cf.</i> (2100)
C ₁₅ H ₂₆ O ₆	Diethyl <i>n</i> -heptoyl- <i>l</i> -malate.....		1.0289	20	-19.30	(1773)
	Dipropyl isovaleryl- <i>l</i> -malate.....		1.0263	20	-21.68	(2089)
C ₁₆ H ₂₈ O ₆	Diethyl <i>n</i> -octoyl- <i>l</i> -malate.....		1.0162	20	-18.21	(1773)
C ₁₆ H ₂₈ O ₆	Diisobutyl <i>n</i> -butyryl- <i>l</i> -malate.....		1.0146	20	-21.68	(2089)
C ₁₇ H ₃₀ O ₆	Diethyl pelargonyl- <i>l</i> -malate.....		1.0073	20	-17.24	(1773)
	Diisobutyl isovaleryl- <i>l</i> -malate.....		1.0045	20	-19.91	(2089)
C ₁₈ H ₃₂ O ₆	Diethyl decoyl- <i>l</i> -malate.....		1.0011	20	-16.61	(1773)
<i>Monoamides of malic acid</i>						
C ₄ H ₇ NO ₄	<i>d</i> -β-Malamie acid [NH ₂ .CO.CH ₂ .CHOH.(COOH)].....	H ₂ O	3		9.70	(1313.5, 1314)
	Silver salt.....	H ₂ O	5		16.4	
C ₆ H ₉ NO ₄	<i>d</i> -β- <i>N</i> -Methylmalamic acid.....	H ₂ O	3.30	20	13.0	(1318)
	Methyl <i>d</i> -β-malamate.....	MeOH	5		12.7	(1313.5)
	Methyl <i>l</i> -β-malamate.....	MeOH	5		-48.48	
C ₇ H ₁₂ N ₂ O ₃	<i>d</i> -β-Malamie allylamide (C ₃ H ₅ .NH.CO.CHOH.CH ₂ .CO.NH ₂).....	MeOH	2.5		49.68	(1313.5)
	<i>l</i> -α-Malamie allylamide.....	MeOH	1.90		-52.25	
C ₉ H ₉ NO ₄	<i>d</i> -Pyridylmalic acid, <div style="display: inline-block; vertical-align: middle; margin-left: 10px;"> $\begin{array}{c} \text{C}_5\text{H}_5\text{N}-\text{O} \\ \\ \text{CO} \end{array} \begin{array}{c} \diagup \\ \diagdown \end{array} \begin{array}{c} \text{CH} \\ \text{CO} \end{array} \text{CH}_2 \text{COOH} \dots$ </div>	0.4 <i>N</i> HCl	5		10.6	(1313.5)
	Sodium salt.....	H ₂ O	3.01		17.01	(1313.5)
C ₁₁ H ₁₃ NO ₄	<i>d</i> -β- <i>N</i> -Benzylmalamic acid [C ₇ H ₇ .NH.CO.CH ₂ .CHOH.COOH].....	MeOH	5		13.6	(1313.5)
	Sodium salt.....	MeOH	2.5		14.32	
		H ₂ O	2.95		33.8	
C ₁₂ H ₁₅ NO ₄	Methyl <i>d</i> -β- <i>N</i> -benzylmalamate.....	MeOH	2.5		12.8	(1313.5)
	Methyl <i>l</i> -β- <i>N</i> -benzylmalamate.....	MeOH	2.5	20	-12.8	(1315)
C ₁₈ H ₁₉ NO ₄	<i>l</i> - <i>N</i> -Dibenzylmalamic acid [(C ₇ H ₇) ₂ N.CO.CH ₂ .CHOH.COOH].....	EtOH	1.25	18.5	-61.6	(1317)
C ₁₈ H ₂₂ N ₂ O ₄	Benzylamine <i>d</i> -β- <i>N</i> -benzylmalamate.....	MeOH	5	20	31.43	(1313.5)
		H ₂ O	2.5		28.0	(1315)
<i>Diamides of malic acid</i>						
C ₄ H ₈ N ₂ O ₃	<i>l</i> -Malic diamide.....	H ₂ O	4.32	20	-37.6	(2089)
		H ₂ O	8.65	20	-38.0	
		AcOH	4.678	20	-45.2	(1321)
		Py	2.00	20	-57.7	
C ₆ H ₁₂ N ₂ O ₃	<i>l</i> -Malic dimethylamide.....	Py	10.08	20	-56.27	(639)
		MeOH	9.982	20	-67.42	
		AcOH	8.185	20	-73.26	
C ₈ H ₁₆ N ₂ O ₃	<i>l</i> -Malic diethylamide.....	Py	10.25	20	-47.41	(639)
		MeOH	9.18	20	-59.47	
		AcOH	7.995	20	-62.34	
C ₁₀ H ₁₆ N ₂ O ₃	<i>l</i> -Malic diallylamide.....	Py	10.4	20	-34.89	(639)
		MeOH	9.1	20	-48.72	
		AcOH	10.8	20	-41.22	
C ₁₀ H ₂₀ N ₂ O ₃	<i>l</i> -Malic diisopropylamide.....	Py	8.99	20	-31.93	(639)
		MeOH	6.04	20	-41.79	
		AcOH	6.28	20	-42.83	
C ₁₀ H ₂₀ N ₂ O ₃	<i>l</i> -Malic di- <i>n</i> -propylamide.....	Py	7.9	20	-41.11	(639)
		Py	4.79	17	-41.9	
		MeOH	11.34	20	-53.10	
		AcOH	9.05	20	-52.20	
		AcOH	4.80	16	-47.4	
C ₁₁ H ₁₄ N ₂ O ₃	<i>d</i> -β- <i>N</i> -Benzylmalamide.....	MeOH	2.5		42.40	(1313.5)

Diamides of malic acid.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.	
C ₁₂ H ₂₄ N ₂ O ₃	<i>l</i> -Malic di- <i>n</i> -butylamide.....	Py	10.85	20	−35.35	(639)	
		MeOH	10.54	20	−45.9		
		AcOH	9.72	20	−43.01		
C ₁₂ H ₂₄ N ₂ O ₃	<i>l</i> -Malic diisobutylamide.....	Py	7.98	20	−36.64		
		MeOH	9.12	20	−48.53		
		AcOH	7.56	20	−43.25		
C ₁₄ H ₂₄ N ₂ O ₃	<i>l</i> -Malic dipiperidide.....	Py	0.598	20	−20.58	(639)	
		MeOH	8.85	20	−27.47		
		AcOH	6.53	20	−15.08		
C ₁₆ H ₁₆ N ₂ O ₃	<i>l</i> -Malic dianilide.....	AcOH	1.50	20	−60.66	(2089)	
		AcOH	0.75	20	−58.66		
C ₁₈ H ₂₀ N ₂ O ₃	<i>l</i> -Malic di- <i>o</i> -toluidide.....	AcOH	2.00	20	−65.0	(2089)	
		AcOH	1.00	20	−66.5		
C ₁₈ H ₂₀ N ₂ O ₃	<i>l</i> -Malic di- <i>p</i> -toluidide.....	AcOH	1.00	20	−70.0		
		AcOH	4.65	22	−20.2		(2089)
C ₁₈ H ₂₀ N ₂ O ₃	<i>l</i> -Malic dibenzylamide.....	Py	4.86	15	−32.4		
		Py	11.01	20	−27.08		(639)
		MeOH	6.00	20	−35.38		
C ₁₈ H ₃₆ N ₂ O ₃	<i>l</i> -Malic di- <i>n</i> -heptylamide.....	AcOH	9.33	20	−31.20		
<i>Imides of malic acid</i>							
C ₁₁ H ₁₁ NO ₃	<i>d</i> -Benzylmalimide.....	EtOH	2	18	58.67	(1316)	
C ₁₈ H ₁₅ NO ₄	<i>d</i> - <i>O</i> -Benzoyl- <i>N</i> -benzylmalimide.....	Me ₂ CO	2		24.7	(1316)	
<i>Methoxysuccinic acid and derivatives</i>							
C ₅ H ₆ Cl ₂ O ₃	<i>l</i> -Methoxysuccinyl chloride.....	C ₆ H ₆	6.4317	20	−54.18	(1747)	
C ₅ H ₆ O ₄	<i>l</i> -Methoxysuccinic anhydride.....	Me ₂ CO	5.6783	20	−83.91	(1747)	
		C ₆ H ₆	4.9973	20	−103.3		
C ₆ H ₈ O ₅	<i>d</i> -Methoxysuccinic acid.....	H ₂ O	11.2	18	33.30	(1738)	
		Me ₂ CO	24.96	11	57.10	(1730)	
		Me ₂ CO	1.65	14	60.09		
		AcOEt	20.5	11	63.48		
		AcOEt	8.92	12	64.64		
		Ammonium hydrogen salt.....	H ₂ O	6.06	14	25.86	(1738)
		Ammonium salt.....	H ₂ O	5.762	14	12.32	(1738)
		Barium salt.....	H ₂ O	26.125	18	−14.27	(1738)
			H ₂ O	12.416	18	−7.36	
			H ₂ O	5.746	18	−2.21	
			H ₂ O	1.149	18	3.16	
		Calcium salt.....	H ₂ O	5.308	18	−10.10	(1738)
		Potassium hydrogen salt.....	H ₂ O	8.15	18.5	23.46	(1738)
		Potassium salt.....	H ₂ O	12.16	15.5	9.54	(1738)
C ₅ H ₈ O ₆	<i>l</i> -Methoxysuccinic acid.....	H ₂ O	6.135	15	−33.56	(1747)	
C ₅ H ₉ NO ₄	<i>l</i> -Methoxysuccinamic acid.....	H ₂ O	4.7777	20	−29.41	(1747)	
		MeOH	3.251	20	−46.75		
C ₅ H ₁₀ N ₂ O ₃	<i>l</i> -Methoxysuccindiamide.....	H ₂ O	7.4860	20	−40.7	(1739)	
		MeOH	1.0460	20	−56.9		
		AcOH	3.9954	20	−41.7		
		Py	0.2740	20	−80.3		
C ₆ H ₁₀ O ₆	Methyl hydrogen <i>l</i> -methoxysuccinate.....	H ₂ O	6.3086	20	−41.85	(1747)	
		H ₂ O	3.1543	20	−43.28		
		Me ₂ CO	6.9747	20	−60.86		
		Me ₂ CO	3.4874	20	−57.64		
		H ₂ O	3.936	16	−19.05		
			1.1415		−62.79		
C ₇ H ₁₂ O ₆	Dimethyl <i>l</i> -methoxysuccinate.....					(1739); cf. (1744)	
		MeOH	20.01	20	−51.5		
		MeOH	10.05	20	−51.3		
		MeOH	5.00	20	−51.7		
		C ₆ H ₆	19.97	20	−65.1		
		C ₆ H ₆	10.02	20	−67.2		
		C ₆ H ₆	5.04	20	−68.3		
			1.0705 ¹³ ₄	18	−50.11		
C ₉ H ₁₆ O ₆	Diethyl <i>l</i> -methoxysuccinate.....		1.0676	20	−50.4	(1744) (1739)	
			1.0476	40	−49.7		
			1.0273	60	−49.2		

Methoxysuccinic acid and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.	
C ₉ H ₁₆ O ₅	Diethyl <i>l</i> -methoxysuccinate.—(Continued) . .	C ₆ H ₆	20.043	20	−58.0		
		C ₆ H ₆	10.01	20	−59.1		
		C ₆ H ₆	5.034	20	−60.6		
		EtOH	19.92	20	−47.1		
		EtOH	9.97	20	−47.7		
		EtOH	5.03	20	−47.8		
		C ₁₁ H ₂₀ O ₅	Dipropyl <i>l</i> -methoxysuccinate.....		1.0419 ₄ ¹⁵	15	−45.21
	1.0312			20	−46.9	(1739)	
	1.0101			40	−46.3		
	0.9908			60	−45.5		
C ₆ H ₆	19.91			20	−52.7		
C ₆ H ₆	10.01			20	−54.2		
C ₆ H ₆	4.99			20	−54.6		
EtOH	19.83			20	−43.6		
EtOH	6.00			20	−43.2		
C ₁₃ H ₂₄ O ₅	Di- <i>n</i> -butyl <i>l</i> -methoxysuccinate.....				1.0419 ₄ ¹⁵	15	−41.63
C ₁₇ H ₁₈ N ₂ O ₃	<i>l</i> -Methoxysuccindianilide.....	MeOH	2.1096	16	−77.5	(1739)	
		AcOH	2.1193	20	−53.3		
		Py	2.4546	20	−66.3		
C ₄₃ H ₅₂ N ₄ O ₇	Dicinchonine <i>d</i> -methoxysuccinate.....	H ₂ O	4	17	154.89	(1738)	
<i>Other alkyloxysuccinic acids and derivatives</i>							
C ₆ H ₁₀ O ₅	<i>d</i> -Ethoxysuccinic acid.....	H ₂ O	11.17	17	33.02	(1743, 1744)	
		CHCl ₃	11.61	12	47.75		
		CHCl ₃	1.60	11	39.40		
		EtOH	11.81	11	60.57		
		AcOEt	11.5	18	69.9		
		Me ₂ CO	9.57	14	−63.39		
		Me ₂ CO	1.53	14	−66.48		
		Ammonium hydrogen salt +H ₂ O.....	H ₂ O	8.13	15	28.65	
		Ammonium salt.....	H ₂ O	5.22	12	18.29	
		Barium salt.....	H ₂ O	4.56	18	6.37	
			H ₂ O	10.77	18	2.46	
		Calcium salt.....	H ₂ O	25.08	19	−4.37	
			H ₂ O	3.04	15	8.39	
			H ₂ O	1.79	15	11.44	
		Potassium hydrogen salt.....	H ₂ O	3.93	19	26.49	
		C ₇ H ₁₂ O ₅	<i>l</i> -Propoxysuccinic acid.....	H ₂ O	7.76	12	−36.40
Me ₂ CO	5.688			12	−63.29		
Barium salt.....	H ₂ O			3.65	18	−10.00	(1730)
C ₈ H ₁₄ O ₅	Dimethyl <i>d</i> -ethoxysuccinate.....		1.1055		59.86	(1740)	
C ₁₀ H ₁₈ O ₅	Diethyl <i>d</i> -ethoxysuccinate.....		1.0418		55.29	(1740)	
C ₁₂ H ₂₂ O ₅	Dipropyl <i>l</i> -ethoxysuccinate.....		1.0226		−51.20	(1740)	
C ₁₄ H ₂₆ O ₅	Di- <i>n</i> -butyl <i>l</i> -ethoxysuccinate.....		1.0045		−46.43	(1740)	
<i>Sulfur derivatives of malic acid</i>							
C ₄ H ₆ O ₄ S	<i>l</i> -Thiomalic acid (HOOC.CH(SH).CH ₂ .COOH).....	AcOEt	5	17	−76.5	(920.2)	
		Me ₂ CO	5	17	−75.8		
		EtOH	5	17	−64.8		
		H ₂ O	5	17	−46.7		
C ₄ H ₇ NO ₃ S	<i>d</i> -β-Thiolsuccinamic acid (NH ₂ .CO.CH(SH)CH ₂ .COOH).....	Me ₂ CO	2.78	18	82.9	(918)	
		H ₂ O	2.75	18	58.7		
		H ₂ O	2.75	19	36.8*	(918)	
C ₆ H ₇ NO ₄ S	<i>d</i> - <i>N</i> -Methyldiketothiazolidineacetic acid, NCH ₃ .CO CO—S CH.CH ₂ .COOH.....	EtOH	2.58		208.0	(1035)	
C ₆ H ₉ NO ₅ S	<i>d</i> - <i>N</i> -Methylcarbamidothiolsuccinic acid (CH ₃ .NH.CO.S.CH(COOH).CH ₂ .COOH) . .	EtOH	1.7		99.2	(1035)	
C ₇ H ₁₁ NO ₄ S ₂	<i>d</i> -β-Ethylxanthosuccinamic acid (NH ₂ .CO.CH(S.CS.OC ₂ H ₅).CH ₂ .COOH) . .	Me ₂ CO	6.59	18	55.5	(918)	
		AcOEt	2.63	17	66		

* Calculated on weight of acid.

Sulfur derivatives of malic acid.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₇ H ₁₁ NO ₅ S	<i>d</i> - <i>N</i> -Dimethylcarbamidothiolsuccinic acid...	EtOH	2.01		81.7	(1035)
	<i>d</i> - <i>N</i> -Ethylcarbamidothiolsuccinic acid.....	EtOH	1.45		103.5	(1035)
Other monohydroxydicarboxylic acids						
C ₅ H ₅ O ₅	<i>d</i> - α -Hydroxyglutaric acid.....	H ₂ O	32.7	25	8.8	(526)
MONOAMINOMONOCARBOXYLIC ACIDS						
Derivatives of glycine (aminoacetic acid, NH ₂ .CH ₂ .COOH)						
C ₅ H ₈ BrNO ₃	<i>l</i> - α -Bromopropionylglycine.....	H ₂ O	8.10	20	−35.27	(474)
	(CH ₃ .CHBr.CO.NH.CH ₂ .COOH).....	EtOH	10.2	20	−46.6	
C ₅ H ₈ BrNO ₃	<i>d</i> - α -Bromopropionylglycine.....	H ₂ O	10.1	18	38.3	(479)
C ₈ H ₁₄ BrNO ₃	<i>d</i> - α -Bromoisohexoylglycine.....	EtOH	9.23	20	62.0	(473)
C ₈ H ₁₄ BrNO ₃	<i>d</i> - α -Bromo- β -methylvaleryl-glycine.....	EtOH	4.44	20	64.42	(13)
C ₁₁ H ₁₂ BrNO ₃	<i>d</i> - α -Bromo- β -phenylpropionylglycine.....	EtOH	4.31	20	−14.65	(546)
Alanine (α -aminopropionic acid, CH ₃ .CH(NH ₂).COOH) and derivatives						
C ₃ H ₈ N ₂ O	<i>d</i> -Alanineamide.....	H ₂ O	5.2		6	(1120)
C ₄ H ₈ N ₂ O ₃	<i>l</i> - α -Carbamidopropionic acid.....	H ₂ O	1.28	20	−9.6	(363)
C ₄ H ₉ NO ₂	<i>d</i> - <i>N</i> -Methylalanine.....	H ₂ O	9.99	20	5.59	(523)
		H ₂ O	8.29	20	5.92	(524)
C ₄ H ₁₀ ClNO ₂	<i>d</i> - <i>N</i> -Methylalanine hydrochloride.....	H ₂ O	9.21	20	5.74	(523)
C ₅ H ₈ ClNO ₃	Chloroacetyl- <i>d</i> -alanine.....	H ₂ O	8.67	20	−45	(547)
C ₅ H ₈ N ₂ O ₂	Glycyl- <i>d</i> -alanine anhydride.....	H ₂ O	4.69	20	−5.0	(547)
C ₅ H ₁₀ N ₂ O ₃	Glycyl- <i>d</i> -alanine.....	H ₂ O	8.68	20	−50	(547)
C ₆ H ₁₀ BrNO ₃	<i>dl</i> - α -Bromopropionyl- <i>d</i> -alanine.....	MeOH	10.7	20	−26.6	(547)
		H ₂ O	2.38	23	−42.4	
	<i>l</i> - α -Bromopropionyl- <i>d</i> -alanine.....	H ₂ O	2.34	21	−16.5	(547)
		MeOH	10.48	21	0.6	
		H ₂ O	5	20	−63.6	(536)
	<i>d</i> - α -Bromopropionyl- <i>l</i> -alanine.....	H ₂ O	2.69	20	67.91	(537)
C ₆ H ₁₀ N ₂ O ₂	<i>d</i> -Alanine anhydride.....	H ₂ O	1.97	20	28.8	(471)
C ₆ H ₁₃ NO ₂	<i>l</i> -Trimethyl- α -propiobetaine*.....	H ₂ O	9.78	20	−19.7	(477)
C ₉ H ₁₆ BrNO ₃	<i>d</i> - α -Bromoisohexoyl- <i>d</i> -alanine.....	EtOH	9.85	20	23.0	(473)
C ₁₀ H ₁₀ N ₂ O	<i>l</i> -Benzoylamino-propionitrile.....	95% EtOH	4.90	15	−55.84	(375)
C ₁₀ H ₁₃ NO ₂	<i>N</i> -Benzylalanine.....	5 <i>N</i> HCl	2.19	20	−3.4	(524)
C ₁₀ H ₁₃ NO ₄ S	<i>p</i> -Toluenesulfonyl- <i>d</i> -alanine.....	EtOH		20	−7.26	(523)
	<i>p</i> -Toluenesulfonyl- <i>l</i> -alanine.....	EtOH	2.36	25	7.71	(717)
C ₁₁ H ₉ NO ₄	Phthalyl- <i>d</i> -alanine.....	EtOH	9.83	20	−17.84	(474)
C ₁₁ H ₁₅ NO ₄ S	<i>p</i> -Toluenesulfonyl- <i>d</i> - <i>N</i> -methylalanine.....	EtOH	10.37	20	−6.67	(546)
C ₁₂ H ₁₇ NO ₄ S	<i>p</i> -Toluenesulfonyl- <i>d</i> -alanine ethyl ester....	EtOH	3.16	20	−34.2	(524)
C ₁₃ H ₁₃ NO ₄	Phthalyl- <i>d</i> -alanine ethyl ester.....	EtOH	10.2	20	−12.33	(474)
C ₁₇ H ₁₉ NO ₄ S	<i>p</i> -Toluenesulfonyl- <i>N</i> -benzyl- <i>d</i> -alanine.....	EtOH	4.88	20	−3.80	(524)
Serine and isoserine and derivatives						
C ₃ H ₇ NO ₃	<i>d</i> -Serine (α -amino- β -hydroxypropionic acid, HO.CH ₂ .CH(NH ₂).COOH).....	H ₂ O	10	20	−16.87	(516, 517)
C ₃ H ₇ NO ₃	<i>l</i> -Isoserine (α -hydroxy- β -aminopropionic acid, NH ₂ .CH ₂ .CHOH.COOH).....	<i>N</i> HCl	8.95	20	−14.32	(516, 517)
		H ₂ O	10	20	−32.58	(516, 517)
C ₁₀ H ₁₁ NO ₄	Benzoyl- <i>l</i> -isoserine.....	H ₂ O	9.98	20	10.5	(516, 517)
C ₁₀ H ₁₀ N ₂ O ₆	<i>p</i> -Nitrobenzoyl- <i>d</i> -serine.....	0.04 <i>N</i> NaOH	10	20	−43.74	(516, 517)
C ₁₁ H ₁₃ NO ₄	<i>d</i> -Benzoyl- α -methylisoserine.....	EtOH	10	20	9.51	(1046)
Cystine and cysteine and derivatives						
C ₃ H ₇ NO ₂ S	Cysteine (HS.CH ₂ .CH(NH ₂).COOH).....	25% HCl	1.00		−224	(1505)
		25% HCl	0.962		−206	
C ₆ H ₁₂ N ₂ O ₄ S ₂	<i>l</i> -Cystine [(S.CH ₂ .CH(NH ₂).COOH) ₂]; cf. (97, 1138.4, 1401.5).....	<i>N</i> HCl	1.89	20	−209.6	(538)
C ₈ H ₁₃ ClN ₂ O ₆ S ₂	Chloroacetyl- <i>l</i> -cystine.....	<i>N</i> HCl	4.63	17	−169.2	(505)
C ₈ H ₁₆ N ₂ O ₄ S ₂	Cystine dimethyl ester.....	EtOH	1.01	20	49.89	(20)
C ₉ H ₁₀ BrNO ₂ S	Bromophenylcysteine.....	dil. NaOH	9		−3.7	(96)
C ₁₀ H ₁₄ Cl ₂ N ₂ O ₆ S ₂	Dichloroacetyl- <i>l</i> -cystine.....	EtOH	10.1	20	−120.3	(505)
		EtOH	9.1		−125.9	(20)
C ₁₀ H ₁₄ Br ₂ N ₂ O ₆ S ₂	Dibromoacetyl- <i>l</i> -cystine.....	EtOH	1.48	20	−107.97	(20)
C ₁₀ H ₁₄ I ₂ N ₂ O ₆ S ₂	Diiodoacetyl- <i>l</i> -cystine.....	EtOH	2.62	20	−95.35	(20)
C ₁₀ H ₂₂ Cl ₂ N ₂ O ₄ S ₂	Diethylecystine dihydrochloride.....	H ₂ O	3.61	20	−47.96	(20)
C ₁₁ H ₁₂ BrNO ₃ S	Bromophenylmercapturic acid.....	EtOH	12–15		−6.7	(96)
		NaOH	25		6.4	

* (CH₃)₃N⁺.CH(CH₃).COO[−].

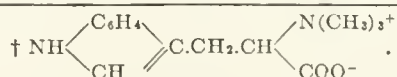
Cystine and cysteine and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₁ H ₁₃ NO ₃ S	Phenylmercapturic acid*.....	EtOH	20		−9.3	(96)
	Sodium salt.....	H ₂ O	8		4.2	(96)
C ₁₂ H ₁₈ Br ₂ N ₂ O ₆ S ₂	Di- <i>d</i> -α-bromopropionyl- <i>l</i> -cystine.....	EtOH	2.13	20	−96.96	(20)
	Di- <i>l</i> -α-bromopropionyl- <i>l</i> -cystine.....	EtOH	2.03	20	−133.23	
C ₁₂ H ₂₂ BrN ₂ O ₅ S ₂	Mono- <i>d</i> -α-bromoisohexoyl- <i>l</i> -cystine†.....	0.273 <i>N</i> NaOH	5.08	21	−130.2	(505)
C ₁₈ H ₃₀ Br ₂ N ₂ O ₆ S ₂	Di- <i>d</i> -α-bromoisohexoyl- <i>l</i> -cystine.....	EtOH	10.0	20	−133.7	(505)
C ₂₆ H ₂₄ N ₂ O ₈ S ₄	Di-β-naphthalenesulfonyl- <i>l</i> -cystine.....	<i>N</i> NaOH	1.98	20	−82.88	(20)
<i>Aminobutyric acid and derivatives</i>						
C ₄ H ₇ N ₃ O ₂	<i>l</i> -α-Triazobutyric acid.....	Et ₂ O	14.29		−63.3	(607)
C ₄ H ₉ NO ₂	<i>l</i> -β-Aminobutyric acid.....	H ₂ O	9.961	20	−35.2	(545)
C ₅ H ₉ NO ₃	Formyl- <i>l</i> -aminobutyric acid.....	H ₂ O	4.56	20	28.0	(19)
C ₅ H ₁₁ N ₃ O ₂	Ethyl <i>l</i> -α-triazobutyrate.....	Et ₂ O	15.84		−48.1	(607)
C ₈ H ₁₅ NO ₄	<i>d</i> -β, β-Iminodibutyric acid [NH(CH ₃ CH ₂ COOH) ₂].....	H ₂ O	10	20	65.3	(1864)
C ₁₀ H ₂₀ ClNO ₄	Dimethyl β, β-iminodibutyrate hydro- chloride.....	MeOH	10.31	20	41.6	(1864)
<i>Valine (α-aminovaleric acid), its isomers and derivatives</i>						
C ₅ H ₁₁ NO ₂	<i>l</i> -Valine [(CH ₃)CH ₂ CH(NH ₂)COOH].....	20% HCl	3.72	20	−28.4	(472)
C ₅ H ₁₁ NO ₂	<i>l</i> -α-Amino-α-methylbutyric acid.....	H ₂ O	5	20	−9.10	{ (409, 413, 414)
		20% HCl	3.67		−6.11	
C ₅ H ₁₁ NO ₂	<i>d</i> -γ-Aminovaleric acid.....	H ₂ O	9.986	20	12.0	(507)
C ₆ H ₁₁ NO ₃	Formyl- <i>l</i> -valine.....	EtOH	11.2	20	−13	(472)
		H ₂ O		20	−16.9	
C ₇ H ₁₂ ClNO ₃	Chloroacetyl- <i>d</i> -valine.....	EtOH	10.1	20	15.8	(544)
C ₈ H ₁₄ BrNO ₃	<i>d</i> -α-Bromopropionyl- <i>d</i> -valine.....	EtOH	9.97	20	21.0	(544)
C ₁₀ H ₁₈ BrNO ₃	<i>l</i> -α-Bromoisovaleryl- <i>d</i> -valine.....	EtOH	9.81	20	−22.7	(544)
C ₁₁ H ₂₀ BrNO ₃	<i>d</i> -α-Bromoisohexoyl- <i>d</i> -valine.....	EtOH	10.2	20	24.3	(544)
C ₁₂ H ₁₅ NO ₃	Benzoyl- <i>d</i> -γ-aminovaleric acid.....	EtOH	10.00	20	−21.9	(507)
C ₁₂ H ₁₆ N ₂ O ₃	<i>l</i> -Valinephenylcarbamide.....	EtOH	4.05	20	−19.02	(472)
<i>n-Leucine (α-amino-<i>n</i>-caproic acid) and derivatives</i>						
C ₆ H ₁₃ NO ₂	<i>l</i> -α-Amino- <i>n</i> -hexoic acid.....	20% HCl	4.56	20	−22.99	{ (1383); cf. (508, 1908.5)
C ₇ H ₁₃ NO ₃	<i>l</i> -Formyl-α-amino- <i>n</i> -hexoic acid.....	EtOH	11.4	20	−17.56	
C ₇ H ₁₅ N ₃ O ₂	<i>d</i> -α-Guanidinoisohexoic acid.....	<i>N</i> HCl	8.12	20	4.54	(1766)
C ₁₃ H ₁₇ NO ₃	<i>l</i> -Benzoyl-α-amino- <i>n</i> -hexoic acid.....	H ₂ O	8.21	20	−21.9	(508)
<i>d- and l-Leucine and derivatives</i>						
C ₆ H ₁₃ NO ₂	<i>d</i> -Leucine[(CH ₃) ₂ CHCH ₂ CH(NH ₂)COOH]; (1259, 1401.5, 1901, 1902)	20% HCl	3.66	20	−15.6	(556); cf. (495)
	<i>l</i> -Leucine.....	21% HCl	4.73	20	−16.91	(467.5)
C ₇ H ₁₃ NO ₃	Formyl- <i>d</i> -leucine.....	EtOH	10	20	18.8	(556)
C ₇ H ₁₅ NO ₂	<i>l</i> - <i>N</i> -Methylleucine.....	H ₂ O	2.98	21	20.76	(523)
C ₇ H ₁₆ ClNO ₂	<i>l</i> - <i>N</i> -Methylleucine hydrochloride.....	H ₂ O	9.18	19	21.57	(523)
C ₈ H ₁₄ ClNO ₃	Chloroacetyl- <i>l</i> -leucine.....	EtOH	8.95	20	−14.4	(549)
C ₉ H ₁₆ BrNO ₃	<i>d</i> -Bromopropionyl- <i>l</i> -leucine.....	<i>N</i> NaOH	3.06	20	−5.87	(475)
C ₁₂ H ₁₇ NO ₄ S	Benzenesulfonyl- <i>d</i> -leucine.....	Alk.	9.94	20	−39	(468)
C ₁₂ H ₂₂ BrNO ₃	<i>d</i> -α-Bromoisohexoyl- <i>l</i> -leucine.....	AcOEt	10	20	16.2	(473)
C ₁₂ H ₂₂ BrNO ₃	<i>l</i> -α-Bromoisohexoyl- <i>l</i> -leucine.....	AcOEt	10.3	20	−34.97	(478)
		0.5 <i>N</i> NaOH	9.95	20	−53.22	
	<i>d</i> -α-Bromoisohexoyl- <i>d</i> -leucine.....	AcOEt	11.0	20	34.70	
		0.5 <i>N</i> NaOH	9.97	20	52.46	
C ₁₃ H ₁₇ NO ₃	Benzoyl- <i>l</i> -leucine.....	0.5 <i>N</i> NaOH	8.79	20	6.59	(467.5)
C ₁₃ H ₁₉ NO ₄ S	<i>p</i> -Toluenesulfonyl- <i>l</i> -leucine.....	EtOH	8.95	20	4.50	(523)
C ₁₄ H ₂₁ NO ₄ S	<i>p</i> -Toluenesulfonyl- <i>l</i> - <i>N</i> -methylleucine.....	EtOH	9.90	18	−21.12	(523)
<i>Other homologues of glycine</i>						
C ₂₄ H ₄₁ NO ₂	<i>d</i> -α-Anilino-stearic acid (C ₁₆ H ₃₃ CH(NH.C ₆ H ₅).COOH).....	Py	3.10	19	34.7	(1202)
		EtOH	0.604	40	18.6	
<i>Arginine and histidine</i>						
C ₆ H ₉ N ₃ O ₂	<i>l</i> -Histidine, glyoxaline-4-alanine†.....	H ₂ O	3.36	22	−37.7	(1749)
	<i>d</i> -Histidine.....	H ₂ O	2.68	23	39.3	(1749)

* Acetylphenylcysteine (C₆H₅.S.CH₂.CH(NHCO.CH₃).COOH).† S.CH₂.CH(COOH).CH.NH.CO.CHBr.C₄H₉
|
S.CH₂.CH(NH₂).COOH.‡ $\begin{array}{c} \text{NH}-\text{C} \\ | \\ \text{CH}=\text{N} \end{array} \text{C} \cdot \text{CH}_2 \cdot \text{CH}(\text{NH}_2) \cdot \text{COOH}.$

Arginine and histidine.—(Continued)

Formula	Name	Solvent	d, C or %	t, °C	[α] _D	Lit.
C ₆ H ₁₄ N ₄ O ₂	<i>l</i> -Arginine, α-amino-δ-guanidino- <i>n</i> -valeric acid*					(1780)
C ₆ H ₁₅ ClN ₄ O ₂	<i>l</i> -Arginine hydrochloride.....			20	−20.51	(1780)
	<i>d</i> -Arginine hydrochloride.....	H ₂ O	8	19	33.1	(1909)
C ₆ H ₁₅ N ₅ O ₅	<i>d</i> -Arginine nitrate.....	H ₂ O	10	19	28.75	(1909)
C ₁₀ H ₁₅ N ₃ O ₈	<i>d</i> -Histidine <i>d</i> -hydrogen tartrate.....	H ₂ O	3.688	28	13.3	(1749)
	<i>l</i> -Histidine <i>l</i> -hydrogen tartrate.....	H ₂ O	4.530	25	−12.1	(1749)
	<i>l</i> -Histidine <i>d</i> -hydrogen tartrate.....	H ₂ O	5.740	27	17.4	(1749)
<i>Tryptophane</i>						
C ₁₁ H ₁₂ N ₂ O ₂	Tryptophane.....	N NaOH	11.4	20	6.12	(15)
	(NH $\begin{array}{c} \diagup \text{C}_6\text{H}_4 \diagdown \\ \diagdown \text{CH} \diagup \end{array}$ C.CH ₂ .CH(NH ₂).COOH)	N NaOH	9.12	20	6.52	(4)
		H ₂ O	0.494	20	−30.33	(4)
C ₁₃ H ₁₃ ClN ₂ O ₃	Chloroacetyl- <i>d</i> -tryptophane.....	EtOH	6.88	20	32.9	(16); cf. (3)
C ₁₃ H ₁₃ IN ₂ O ₃	Iodoacetyl- <i>l</i> -tryptophane.....	EtOH	4.92	20	31.3	(3)
C ₁₄ H ₁₈ N ₂ O ₂	Hypaphorine (the betaine of tryptophane)†.	H ₂ O	1.66		94.7	(1791)
C ₁₇ H ₂₁ BrN ₂ O ₃	<i>d</i> -α-Bromoisohehexoyl- <i>d</i> -tryptophane.....	EtOH	11.2	20	27.1	(16)
<i>Phenylglycine and derivatives</i>						
C ₉ H ₉ NO ₂	<i>l</i> -α-Aminophenylacetic acid.....	H ₂ O		20	−90.35	{ (413, 414); cf. (142)
	[C ₆ H ₅ .CH(NH ₂).COOH]	10% HCl	3.67	20	−144.95	
		0.31N HCl	7.19	20	−157.8	
C ₉ H ₉ NO ₃	<i>l</i> -Formylaminophenylacetic acid.....	EtOH	4	20	−259.8	(557)
C ₁₀ H ₁₄ ClNO ₂	Ethyl <i>l</i> -aminophenylacetate hydrochloride..	H ₂ O	5.02	20	88.95	(557)
C ₁₄ H ₁₃ NO ₂	<i>l</i> -Phenylanilinoacetic acid.....	Me ₂ CO	1.47		−117.9	
		EtOH	1.02		−111.7	
		AcOEt	2.06		−106.8	
C ₁₅ H ₁₄ N ₂ O ₃	<i>l</i> -α-Aminophenylacetic acid phenylurea.....	0.5N NaOH	5.15	20	−129.27	(413, 414)
<i>Phenylalanine and derivatives</i>						
C ₉ H ₁₁ NO ₂	<i>d</i> -Phenylalanine					
	[C ₆ H ₅ .CH ₂ .CH(NH ₂).COOH].....	H ₂ O	1.75	20	35.14	(546)
		H ₂ O	2.03	16	35.08	(527)
		H ₂ O	3.48	20	6.86	
		20% HCl	2.01	20	34.56	(409, 413, 414)
C ₉ H ₁₁ NO ₄	<i>l</i> -3, 4-Dihydroxyphenylalanine.....	HCl.H ₂ O	3.81	15	−12.74	(2132)
C ₁₀ H ₁₁ NO ₃	Formyl- <i>d</i> -phenylalanine.....	EtOH	4.2	20	−75.43	(546)
C ₁₀ H ₁₃ NO ₂	<i>N</i> -Methyl- <i>d</i> -phenylalanine.....	0.1N NaOH	1.58	18	−48.22	(523)
		N HCl	5.86	20	−17.7	
C ₁₁ H ₁₂ ClNO ₃	<i>N</i> -Chloroacetyl- <i>l</i> -phenylalanine.....	EtOH	3.64	20	51.8	(546)
C ₁₁ H ₁₆ ClNO ₂	<i>l</i> -Phenylalanine ethyl ester hydrochloride..	H ₂ O	3.14	20	−7.6	(546)
C ₁₆ H ₁₅ NO ₃	Benzoyl- <i>d</i> -phenylalanine.....	1.4% KOH	6.36	20	−17.1	(527)
C ₁₆ H ₁₇ NO ₄ S	<i>p</i> -Toluenesulfonyl- <i>d</i> -phenylalanine.....	Me ₂ CO	7.40	20	2.30	(523)
C ₁₇ H ₁₉ NO ₄ S	<i>p</i> -Toluenesulfonyl- <i>d</i> -methylphenylalanine ..	Me ₂ CO	7.46	20	32.63	(523)
		0.5N NaOH	6.39	20	−8.58	
C ₁₆ H ₁₇ NO ₂	<i>N</i> -Benzylphenylalanine.....	0.4N NaOH	5.9	18	17.58	(524)
<i>Tyrosine (β-<i>p</i>-hydroxyphenylalanine) and derivatives</i>						
C ₉ H ₉ I ₂ NO ₃	2, 5-Diiodo- <i>l</i> -tyrosine.....	25% NH ₃	4.73	20	2.27	(11)
		4% HCl	4.83	20	2.89	
C ₉ H ₁₀ N ₂ O ₆	<i>l</i> -3-Nitrotyrosine.....	4% HCl	5.29	16	−16.2	(1913)
C ₉ H ₁₁ NO ₃	Tyrosine [HO.C ₆ H ₄ .CH ₂ .CH(NH ₂).COOH]..	21% HCl	4.5	16.2	−7.98	{ (1401); cf. (1257, 1259, 1901)
		11.6% KOH	5.8	20.5	−9.01	
		11.6% KOH	11.5	16.1	8.86	
C ₉ H ₁₂ N ₂ O ₂	<i>l</i> -Tyrosineamide.....	H ₂ O	6.07	20	19.49	(1120)
C ₁₀ H ₁₁ NO ₄	Formyl- <i>l</i> -tyrosine.....	EtOH	5.37	20	84.9	(476)
C ₁₁ H ₁₅ NO ₃	<i>l</i> -Tyrosine ethyl ester.....	EtOH	4.85	20	20.4	(468)
C ₁₂ H ₁₃ NO ₆	Formyl- <i>l</i> -tyrosine methylcarbonate.....	EtOH	5.3	20	66.7	(480)
C ₁₃ H ₁₄ ClNO ₆	Chloroacetylcarbomethoxy- <i>l</i> -tyrosine.....	EtOH	9.98	20	48.7	(480); cf. (481)

* NH₂.C(=NH)NH(CH₂)₃.CH(NH₂).COOH.

Tyrosine (β-p-hydroxyphenylalanine) and derivatives.—(Continued)

Formula	Name	Solvent	d, C or %	t, °C	[α] _D	Lit.
C ₁₆ H ₁₅ NO ₄	Benzoyl- <i>l</i> -tyrosine.....	8% NaOH	8.04	20	19.25	(467)
C ₁₆ H ₁₇ NO ₅ S	<i>O</i> - <i>p</i> -Toluenesulfonyl- <i>l</i> -tyrosine.....	N HCl	6.33	17	-4.58	(486.5)
		N NaOH	6.17	17	-11.68	
C ₁₈ H ₂₁ NO ₅ S	<i>N</i> - <i>p</i> -Toluenesulfonyl- <i>l</i> -tyrosine.....	EtOH	7.24	21	-0.85	(523)
C ₁₈ H ₂₁ NO ₅ S	<i>N</i> - <i>p</i> -Toluenesulfonyl- <i>l</i> -tyrosine ethyl ester...	EtOH	7.27	17	6.76	(523)
C ₂₄ H ₂₅ NO ₇ S ₂	<i>N</i> - <i>p</i> -Toluenesulfonyl- <i>O</i> , <i>N</i> -dimethyltyrosine...	EtOH	6.83	20	-26.75	(523)
	Di-(<i>p</i> -Toluenesulfonyl)- <i>N</i> -methyltyrosine...	EtOH	3.11	21	-25.34	(486.5)
DIAMINOMONOCARBOXYLIC ACIDS						
C ₃ H ₈ N ₂ O ₂	<i>d</i> -Diaminopropionic acid, sodium salt from dihydrochloride.....	N HCl	4.84	20	25.0	(1040)
C ₃ H ₁₀ Cl ₂ N ₂ O ₂	<i>l</i> -Diaminopropionic acid, sodium salt from dihydrochloride.....	N NaOH	9.87	20	25	
	All calculated on dihydrochloride	N NaOH	11.8		-1.8	(517)
		2N NaOH	6.15	20	-8.1	
C ₁₇ H ₁₅ N ₂ O ₄ Na	Dibenzoyl- <i>d</i> -diaminopropionic acid, sodium salt.....	H ₂ O	10	20	-35.76*	(517)
MONOAMINODICARBOXYLIC ACIDS						
<i>Aspartic acid and derivatives</i>						
C ₄ H ₇ NO ₄	<i>d</i> -Aspartic acid					
C ₄ H ₈ N ₂ O ₃	[CH ₂ (COOH).CH(NH ₂).COOH].....	dil. NaOH	0.366	20	-2.48	(1038)
	<i>l</i> -Asparagine [C ₂ H ₃ (NH ₂).COOH.CO.NH ₂]	H ₂ O	1.961	34	-6.7	(1332)
C ₆ H ₉ NO ₄	<i>l</i> -Methylaspartic acid.....	H ₂ O	0.5525		-15.44	(1318)
		0.055N HCl	0.5525		-22.6	
		0.158N HCl	0.5525		-28.9	
		1.57N HCl	0.5525		-30.8	
		0.25N NaOH	0.5525		-29.8	
C ₇ H ₁₂ N ₂ O ₄	Methyl <i>l</i> -acetylaspargate.....	H ₂ O	2.13	19	-41.14	(1040)
C ₈ H ₁₅ NO ₄	<i>l</i> -Diethyl aspartate.....		1.089 ¹⁷	20	-9.46	(468)
C ₁₀ H ₁₇ BrN ₂ O ₄	<i>d</i> -α-Bromoisohexoyl- <i>l</i> -asparagine.....	N NaOH	5.7	20	15.7	(520); cf., (519)
	<i>l</i> -α-Bromoisohexoyl- <i>l</i> -asparagine.....	N NaOH	5.7	20	-30.1	
C ₁₂ H ₁₂ BrNO ₅	Phenylbromoacetylaspargic acid [C ₆ H ₅ -CHBr.CO.NH.CH(COOH).CH ₂ .COOH]	0.161N NaOH	9.5	20	3.6	(554)
		0.183N NaOH	9.5	20	3.6	(535)
C ₁₂ H ₁₃ BrN ₂ O ₄	Phenylbromoacetylaspargine.....	0.5N NaOH	12.66	20	3.33	(335, 554)
C ₁₆ H ₂₀ BrNO ₅	Diethyl phenylbromoacetylaspargate [C ₆ H ₅ .CHBr.CO.NH.CH(CO.OC ₂ H ₅).CH ₂ .CO.OC ₂ H ₅].....	EtOH	5.21	20	-13.40	(554)
		EtOH	5.21	20	-13.23	(535)
<i>Glutamic acid and derivatives</i>						
C ₆ H ₇ NO ₃	<i>d</i> -Pyroglutamic acid.....	H ₂ O	2.665	25	7	(1862)
C ₆ H ₉ NO ₄	<i>d</i> -Glutamic acid					
	[HO.CO.CH ₂ .CH ₂ .CH(NH ₂).COOH].....	H ₂ O	2	21	10.2	(1862)
	(Supersaturated).....	H ₂ O	4	23	10.6	
		dil. HNO ₃	4	22	29.9	
	Calcium salt.....	H ₂ O	5.03	20	-3.7	(1862)
C ₆ H ₁₀ ClNO ₄	<i>d</i> -Glutamic acid hydrochloride.....	H ₂ O	4	21	20.4	(1862)
C ₇ H ₁₀ ClNO ₅	Chloroacetyl- <i>d</i> -glutamic acid.....	H ₂ O	9.93	20	-13.5	(521)
C ₉ H ₁₄ N ₂ O ₄	Diethyl α-diazoglutarate.....	Et ₂ O	50	20	2.70	(1238)
C ₉ H ₁₇ NO ₄	<i>d</i> -Diethyl glutamate.....		1.0737 ¹⁷	20	7.34	(468)
POLYPEPTIDES†						
C ₅ H ₁₀ N ₂ O ₃	<i>d</i> -Alanylglycine.....	H ₂ O	10	18	50.3	(479)
C ₆ H ₁₁ N ₃ O ₄	Glycylasparagine.....	H ₂ O	7	20	-6.4	(519)
C ₆ H ₁₂ N ₂ O ₃	<i>d</i> -Alanyl- <i>d</i> -alanine.....	H ₂ O	4.93	20	-21.6	(471)
	<i>l</i> -Alanyl- <i>d</i> -alanine.....	H ₂ O		20	-68.5	(536)
	<i>d</i> -Alanyl- <i>l</i> -alanine.....	H ₂ O	7.42	20	68.94	(537)
C ₇ H ₁₀ N ₂ O ₂	<i>l</i> -Prolylglycyl anhydride‡.....	H ₂ O	7.45	20	-216.2	(540)
C ₇ H ₁₁ BrN ₂ O ₄	<i>d</i> -α-Bromopropionylglycylglycine.....	Alk.	8.6	20	29.7	(479)
C ₇ H ₁₁ ClN ₂ O ₄	Chloroacetyl- <i>d</i> -alanylglycine.....	H ₂ O	5	18	-53.4	(479)
C ₇ H ₁₂ N ₂ O ₂	Glycyl- <i>d</i> -valine anhydride.....	AcOH	10.1	20	20.8	(544)
		H ₂ O	1.99		32.7	
		EtOH	0.537		41	
C ₇ H ₁₂ N ₂ O ₅	Glycyl- <i>d</i> -glutamic acid.....	H ₂ O	10.0	20	-6.3	(521)

* Calculated on weight of acid.

† This table includes polypeptides which contain two or more asymmetric carbon atoms (IB₁, etc.) and also those which contain isoleucine groups (IC).

‡ These derivatives were not made from optically pure substances, but this is, apparently, the only work on such compounds.

POLYPEPTIDES.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₇ H ₁₃ N ₃ O ₄	Glycyl- <i>d</i> -alanylglycine.....	H ₂ O	4.81.	20	−64.3	(479)
C ₇ H ₁₃ N ₃ O ₄	<i>d</i> -Alanylglycylglycine.....	H ₂ O	9.71	20	31.4	(479)
C ₇ H ₁₃ N ₃ O ₄	<i>l</i> -Alanylglycylglycine.....	H ₂ O	10.4	20	−29.2	(473)
C ₇ H ₁₄ N ₂ O ₃	<i>d</i> -Valylglycine.....	H ₂ O	10.4	20	93.6	(544)
		10% HCl	1.78	20	39.4	
C ₇ H ₁₄ N ₂ O ₃	Glycyl- <i>d</i> -valine.....	H ₂ O	9.9	20	−19.7	(544)
		HCl aq.	9.97	20	−10.5	
		NaOH	9.27	20	−6.9	
C ₈ H ₁₄ N ₂ O ₂	Glycyl- <i>d</i> -isoleucine anhydride.....	AcOH	2.85	20	−26.05	(13)
C ₈ H ₁₄ N ₂ O ₂	<i>d</i> -Alanyl- <i>d</i> -valine anhydride.....	AcOH	10.0	20	−29.3	(544)
C ₈ H ₁₄ N ₂ O ₂	<i>l</i> -Leucylglycine anhydride.....	H ₂ O	1.85	20	32.95	(473)
C ₈ H ₁₆ N ₂ O ₃	<i>d</i> -Alanyl- <i>d</i> -valine.....	N HCl	9.9	20	−1.9	(544)
		N NaOH	9.48		−4.5	
C ₈ H ₁₆ N ₂ O ₃	Glycyl- <i>l</i> -leucine.....	H ₂ O	6.65	20	−34.9	(549)
		H ₂ O	3.093	20	−35.23	(9)
		EtOH	10.21	20	−13.82	
C ₈ H ₁₆ N ₂ O ₃	Glycyl- <i>d</i> -isoleucine.....	H ₂ O	4.2	20	−14.7	(13)
C ₈ H ₁₆ N ₂ O ₃	<i>d</i> -Isoleucylglycine.....	H ₂ O	5.9	20	33.59	(13)
C ₈ H ₁₆ N ₂ O ₃	<i>l</i> -Leucylglycine.....	H ₂ O	8.6	20	85.5	(473)
		EtOH	2.912	20	−63.39	(9)
		H ₂ O	1.998	20	−84.56	
C ₈ H ₁₆ N ₂ O ₃	<i>d</i> -Leucylglycine.....	H ₂ O	3.453	20	37.33	
C ₉ H ₁₆ N ₂ O ₂	<i>d</i> -Alanyl- <i>d</i> -isoleucine anhydride.....	AcOH	5.85	20	−16.6	(13)
C ₉ H ₁₆ N ₂ O ₂	<i>l</i> -Leucyl- <i>d</i> -alanine anhydride.....	AcOH	9.10	20	−29.0	(473)
C ₉ H ₁₆ N ₄ O ₅	<i>d</i> -Alanyldiglycylglycine.....	H ₂ O	3.19	20	27	(14)
C ₉ H ₁₆ N ₄ O ₅	<i>d</i> -Alanylglycylglycylglycine.....	H ₂ O	8.98	20	22.4	(17)
C ₉ H ₁₈ N ₂ O ₃	<i>d</i> -Alanyl- <i>d</i> -isoleucine.....	N HCl	3.72	20	6.1	(13)
		N NaOH	4.81	20	−297	(13)
C ₉ H ₁₈ N ₂ O ₃	<i>d</i> -Alanyl- <i>l</i> -leucine.....	H ₂ O	1.761	20	−16.96	(9)
		H ₂ O	8.78	20	−17.21	(475)
	<i>l</i> -Leucyl- <i>d</i> -alanine.....	MeOH	3.829	20	19.84	(9)
		MeOH	4.83	20	23.7	(473)
C ₁₀ H ₁₇ BrN ₂ O ₄	<i>d</i> -Bromoisocaproylglycylglycine.....	EtOH	4.36	20	47.01	(10)
		H ₂ O	1.45	20	31.17	
		0.1N NaOH	2.67	20	26.24	
C ₁₀ H ₁₈ N ₂ O ₂	<i>trans</i> -Valine anhydride.....	AcOH	2.2		±0	(544)
C ₁₀ H ₁₈ N ₄ O ₆ S ₂	Diglycyl- <i>l</i> -cystine.....	H ₂ O	4.00	20	−99.91	(20)
C ₁₀ H ₁₉ N ₃ O ₄	<i>d</i> -Leucyl- <i>l</i> -asparagine.....	H ₂ O	4.78	20	−53.6	(520)
	<i>l</i> -Leucyl- <i>l</i> -asparagine.....	H ₂ O	5.57	20	17.8	
C ₁₀ H ₁₉ N ₃ O ₄	<i>l</i> -Leucylglycylglycine.....	H ₂ O	4.53	20	44.79	(10)
C ₁₀ H ₂₀ N ₂ O ₃	<i>l</i> -Valyl- <i>d</i> -valine.....	H ₂ O	10.0	20	−74.0	(544)
C ₁₁ H ₁₂ I ₂ N ₂ O ₄	Glycyl-2, 4-diiodo- <i>l</i> -tyrosine.....	25% NH ₃	5.07	20	52.69	(11)
C ₁₁ H ₁₂ N ₂ O ₂	Glycyl- <i>l</i> -phenylalanine anhydride.....	AcOH	2.57	20	100.5	(546)
C ₁₁ H ₁₄ N ₂ O ₃	<i>l</i> -Phenylalanylglycine.....	H ₂ O	2.41	20	54.20	(546)
C ₁₁ H ₁₄ N ₂ O ₃	Glycyl- <i>l</i> -phenylalanine.....	H ₂ O	2.05	20	41.4	(546)
C ₁₁ H ₁₆ N ₂ O ₂	<i>l</i> -Prolylleucine anhydride*.....	EtOH	3.06	20	−143.4	(540)
C ₁₁ H ₁₉ BrN ₂ O ₄	<i>d</i> - α -Bromopropionyl- <i>l</i> -leucylglycine.....	EtOH	5.095	20	−24.84	(9)
C ₁₁ H ₁₉ BrN ₂ O ₄	<i>d</i> - α -Bromoisocaproyl- <i>d</i> -alanylglycine.....	EtOH	4.918	20	−2.52	(9)
C ₁₁ H ₁₉ BrN ₂ O ₄	<i>d</i> - α -Bromopropionylglycyl- <i>l</i> -leucine.....	EtOH	7.720	20	14.71	(9)
C ₁₁ H ₁₉ BrN ₂ O ₄	<i>d</i> - α -Bromoisohexoylglycyl- <i>d</i> -alanine.....	EtOH	10.2	20	20.4	(549)
C ₁₁ H ₁₉ ClN ₂ O ₄	Chloroacetyl- <i>l</i> -leucyl- <i>d</i> -alanine.....	EtOH	4.583	20	−41.52	(9)
C ₁₁ H ₂₀ N ₂ O ₂	<i>l</i> -Leucyl- <i>d</i> -valine anhydride.....	AcOH	5.01	20	−50.2	(544)
C ₁₁ H ₂₀ N ₂ O ₅	<i>l</i> -Leucyl- <i>d</i> -glutamic acid.....	N HCl	8.20	20	10.5	(476)
C ₁₁ H ₂₁ N ₃ O ₄	<i>d</i> -Alanyl- <i>l</i> -leucylglycine.....	H ₂ O	2.092	28	−30.43	(9)
C ₁₁ H ₂₁ N ₃ O ₄	<i>d</i> -Alanylglycyl- <i>l</i> -leucine.....	H ₂ O	2.131		−11.20	(9)
C ₁₁ H ₂₁ N ₃ O ₄	<i>l</i> -Leucylglycyl- <i>d</i> -alanine.....	H ₂ O	9.89	20	20.3	(549)
C ₁₁ H ₂₂ N ₂ O ₃	<i>l</i> -Leucyl- <i>d</i> -valine.....	H ₂ O	10.0	20	18.0	(544)
C ₁₂ H ₁₄ I ₂ N ₂ O ₄	<i>dl</i> -Alanyl-3, 5-diiodo- <i>l</i> -tyrosine.....	25% NH ₃	6.48	20	47.23	(12)
C ₁₂ H ₁₄ I ₂ N ₂ O ₄	<i>d</i> -Alanyl-3, 5-diiodo- <i>l</i> -tyrosine.....	25% NH ₃	7.95	20	62.88	(14)
C ₁₂ H ₁₅ N ₃ O ₄	Phenylglycylasparagine.....	0.334N NaOH	6.015	20	−2.3	(554)
C ₁₂ H ₁₆ N ₂ O ₄	<i>d</i> -Alanyl- <i>l</i> -tyrosine.....	H ₂ O	2.04	20	43.14	(14)
C ₁₂ H ₂₀ BrN ₃ O ₅	α -Bromoisohexoyldiglycylglycine.....	0.3N NaOH	8.54	20	31.98	(473)
C ₁₂ H ₂₀ N ₄ O ₃	<i>l</i> -Leucyl- <i>l</i> -histidine.....	H ₂ O	5.06	20	32.06	(496)

* These derivatives were not made from optically pure substances, but this is, apparently, the only work on such compounds.

POLYPEPTIDES.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₂ H ₂₂ N ₂ O ₂	<i>l</i> -Leucine anhydride.....	AcOH	8.09	20	−42.8	(473)
C ₁₂ H ₂₂ N ₂ O ₂	<i>d</i> -Leucine anhydride.....	AcOH	8.70	20	48.67	(478)
C ₁₂ H ₂₂ N ₄ O ₆	Glycyl- <i>l</i> -asparaginy- <i>l</i> -leucine.....	N HCl	5.2	20	−46.5	(520)
C ₁₂ H ₂₂ N ₄ O ₆	<i>l</i> -Leucyldiglycylglycine.....	H ₂ O	9.54	20	45.85	(473)
C ₁₂ H ₂₂ N ₄ O ₆ S ₂	Di- <i>l</i> -alanyl- <i>l</i> -cystine.....	N HCl	1.02	20	−227.9	(20); cf. (552)
C ₁₂ H ₂₄ N ₂ O ₃	<i>d</i> -Leucyl- <i>l</i> -leucine.....	N HCl	9.83	20	−67.97	(478)
	<i>l</i> -Leucyl- <i>d</i> -leucine.....	N HCl	9.70	20	68.95	
	<i>d</i> -Leucyl- <i>d</i> -leucine.....	N NaOH	11.9	20	13.16	
	<i>l</i> -Leucyl- <i>l</i> -leucine.....	N NaOH	4.33	20	−13.43	(473)
	<i>l</i> -Leucyl- <i>d</i> -isoleucine.....	N HCl	2.67	20	20.17	(13)
C ₁₃ H ₁₃ NO	<i>l</i> -2-β-Hydroxy-β-phenylethylpyridine.....	CHCl ₃	13.2	25	−36.44	(1267)
C ₁₃ H ₁₆ N ₃ O ₃	Glycyl- <i>d</i> -tryptophane.....	N HCl	9.58	20	−21.45	(16)
C ₁₃ H ₁₆ N ₃ O ₃	Tryptophanylglycine.....	H ₂ O	4.43	20	78.7	(16)
C ₁₄ H ₁₇ N ₃ O ₃	<i>d</i> -Alanyl- <i>d</i> -tryptophane, copper salt.....	H ₂ O	6.11	20	18.65	(16)
C ₁₄ H ₁₆ N ₃ O ₂	<i>dl</i> -Alanyl- <i>l</i> -tryptophane anhydride.....	AcOH	9.47	20	87.0	(3)
C ₁₄ H ₁₇ BrN ₂ O ₅	<i>d</i> -α-Bromopropionylglycyltyrosine.....	H ₂ O	4.14	20	5.06	(476)
C ₁₄ H ₁₉ N ₃ O ₅	<i>d</i> -Alanylglycyl- <i>l</i> -tyrosine.....	H ₂ O	4.58	20	41.9	(476)
C ₁₄ H ₁₉ N ₃ O ₅	Glycyl- <i>d</i> -alanyl- <i>l</i> -tyrosine.....	H ₂ O	4.5	20	−4.83	(14)
C ₁₄ H ₂₃ BrN ₄ O ₆	<i>d</i> -Bromoisocaproyltriglycylglycine.....	H ₂ O	1.29	20	22.55	(10)
		0.1N NaOH	3.18	20	25.47	
C ₁₄ H ₂₄ N ₅ O ₇	<i>l</i> -Alanyldiglycyl- <i>l</i> -alanylglycylglycine.....	H ₂ O	7.86	21	13	(473)
C ₁₄ H ₂₆ BrN ₂ O ₄	<i>d</i> -α-Bromoisohexoylglycyl- <i>l</i> -leucine.....	EtOH	9.90	20	29.1	(549)
C ₁₄ H ₂₆ N ₅ O ₆	<i>l</i> -Leucyltriglycylglycine.....	H ₂ O	3.19	20	28.14	(10)
C ₁₅ H ₂₂ N ₂ O ₄	<i>l</i> -Leucyl- <i>l</i> -tyrosine.....	H ₂ O	2.11	20	10.37	(14)
C ₁₅ H ₁₆ N ₂ O ₆ S	β-Naphthalenesulfo- <i>d</i> -alanylglycine.....	0.47N NaOH	5.18		−63.71*	(492)
C ₁₆ H ₁₉ N ₃ O ₅	<i>l</i> -Tryptophanyl- <i>d</i> -glutamic acid.....	H ₂ O	4.33	20	34.35	(2)
C ₁₆ H ₂₂ N ₄ O ₆	Glycyl- <i>d</i> -alanylglycyl- <i>l</i> -tyrosine.....	H ₂ O	9.72	20	4.0	(479)
C ₁₇ H ₂₃ N ₃ O ₃	<i>l</i> -Leucyl- <i>d</i> -tryptophane.....	N HCl	7.16	20	4.48	(16)
C ₁₈ H ₂₉ BrN ₆ O ₈	<i>d</i> -α-Bromoisocaproylpentaglycylglycine....	0.1N NaOH	3.31	20	18.19	(10)
C ₁₈ H ₃₁ BrN ₄ O ₆	<i>d</i> -α-Bromoisohexoyltriglycyl- <i>l</i> -leucine.....	N NaOH	7.12	20	23.5	(549)
C ₁₈ H ₃₁ N ₇ O ₈	<i>l</i> -Leucylpentaglycylglycine.....	N NaOH	4.97	20	5.94	(10)
C ₁₈ H ₃₃ N ₅ O ₆	<i>l</i> -Leucyltriglycyl- <i>l</i> -leucine.....	H ₂ O	2.5	20	21.3	(549)
C ₁₈ H ₃₄ N ₄ O ₆ S ₂	Di- <i>l</i> -leucyl- <i>l</i> -cystine.....	N HCl	2.56	20	−136.6	(505)
C ₁₉ H ₂₄ BrN ₃ O ₄	<i>d</i> -α-Bromoisohexoylglycyl- <i>d</i> -tryptophane....	EtOH	11.4	20	54.47	(16)
C ₁₉ H ₂₆ N ₄ O ₄	<i>l</i> -Leucylglycyl- <i>d</i> -tryptophane.....	N HCl	8.16	20	32.30	(16)
C ₂₀ H ₃₂ BrN ₇ O ₉	<i>d</i> -α-Bromoisohexoylhexaglycylglycine.....	N NaOH	7.94	20	3.55	(475)
C ₂₀ H ₃₄ N ₈ O ₉	<i>l</i> -Leucylhexaglycylglycine.....	N NaOH	6.32	20	6.34	(475)
C ₂₁ H ₂₀ N ₂ O ₆ S	β-Naphthalenesulfoglycyltyrosine.....	0.34N NaOH	5.05	20	17.9*	(492)
C ₂₁ H ₂₉ BrN ₄ O ₇	<i>d</i> -α-Bromoisohexoyltriglycyl- <i>l</i> -tyrosine.....	H ₂ O	1.23	20	28.7	(476)
C ₂₁ H ₃₁ N ₅ O ₇	<i>l</i> -Leucyltriglycyl- <i>l</i> -tyrosine.....	H ₂ O	4.82	20	36.5	(476)
C ₂₂ H ₃₀ N ₄ O ₆	<i>l</i> -Leucyl- <i>l</i> -tryptophanyl- <i>d</i> -glutamic acid....	N HCl	4.03	20	17.4	(2)
C ₂₂ H ₃₆ Cl ₂ N ₄ O ₈ S ₂	Dichloroacetyldi- <i>l</i> -leucyl- <i>l</i> -cystine.....	EtOH	1.58	20	−102.8	(20)
C ₂₂ H ₃₆ Br ₂ N ₄ O ₈ S ₂	Dibromoacetyl-di- <i>l</i> -leucyl- <i>l</i> -cystine.....	EtOH	1.69	20	−55.81	(20)
	Di- <i>d</i> -α-bromoisocaproyl-diglycyl- <i>l</i> -cystine...	EtOH	2.49	20	−21.76	
C ₂₂ H ₄₀ N ₆ O ₈ S ₂	Di- <i>l</i> -leucyldiglycyl- <i>l</i> -cystine.....	H ₂ O	0.77	20	−72.24	(20)
		N HCl		20	−75.45	
C ₂₂ H ₄₀ N ₆ O ₈ S ₂	Diglycyl-di- <i>l</i> -leucyl- <i>l</i> -cystine.....	H ₂ O	0.728	20	−108.86	(20)
		N HCl	0.837	20	−134.46	
C ₂₄ H ₄₀ Br ₂ N ₄ O ₈ S ₂	Di- <i>d</i> -α-bromoisocaproyl-di- <i>d</i> -alanyl- <i>l</i> -cystine	EtOH	1.88	20	−54.53	(20)
C ₃₀ H ₃₀ N ₄ O ₁₀ S ₄	Di-β-naphthalenesulfono-diglycyl- <i>l</i> -cystine..	N NaOH	0.72	20	−91.8	(20)
C ₃₀ H ₄₉ BrN ₁₀ O ₁₂	<i>d</i> -α-Bromoisocaproyltriglycyl- <i>l</i> -leucylpenta- glycylglycine.....	0.1N NaOH	4.34	20	7.34	(10)
C ₃₀ H ₅₁ N ₁₁ O ₁₂	<i>l</i> -Leucyltriglycyl- <i>l</i> -leucylpentaglycylglycine..	NaOH	1	20	−6	(10)
C ₄₂ H ₆₉ BrN ₁₄ O ₁₆	<i>d</i> -α-Bromoisocaproyltriglycyl- <i>l</i> -leucyltri- glycyl- <i>l</i> -leucylpentaglycylglycine.....	0.1N NaOH	3.75	20	−4	(10)
C ₄₂ H ₇₁ N ₁₅ O ₁₆	<i>l</i> -Leucyltriglycyl- <i>l</i> -leucyltriglycyl- <i>l</i> -leucyl- pentaglycylglycine.....	0.1N NaOH	0.83	20	−9.63	(10)
C ₅₄ H ₈₉ BrN ₁₈ O ₂₀	<i>d</i> -α-Bromoisocaproyltriglycyl- <i>l</i> -leucyltrigly- cyl- <i>l</i> -leucyltriglycyl- <i>l</i> -leucylpentaglycylgly- cine.....	0.1N NaOH	2.5	20	−8	(10)
C ₅₄ H ₉₁ N ₁₉ O ₂₀	<i>l</i> -Leucyltriglycyl- <i>l</i> -leucyltriglycyl- <i>l</i> -leucyl- triglycyl- <i>l</i> -leucylpentaglycylglycine.....	0.1N NaOH	0.95	20	−8.42	(10)

* For white light.

IB₂. The Molecule Contains Two Asymmetric Carbon Atoms Which Are Attached Each to Two Other Carbon Atoms
 ALCOHOLS AND AMINES

POLYHYDRIC ALCOHOLS (SUGARS AND DERIVATIVES)

Formula	Name	Solvent	d, C or %	$t, ^\circ C$	$[\alpha]_D$	Lit.
$C_4H_6O_4$	<i>d</i> -Erythronic acid lactone.....	$H_2O?$	8.04	20	-73.3	(1805)
$C_4H_8O_4$	<i>l</i> -Erythrose.....	H_2O	5.29	20	21.5*	(1806)
$C_4H_{10}O_4$	<i>l</i> -Erythritol ($HO.CH_2.CHOH.CHOH.CH_2.OH$).....	H_2O	6		4.3	(1372)
		EtOH	1.5		-15	
		H_2O	20		-4.25	(1374)
		90% EtOH	20		-10.50	
$C_5H_{11}NO_4$	Pentane-3, 4, 5-triolal oxime ($HO.CH_2.(CHOH)_2.CH_2.CH:NOH$).....	H_2O	4.2		10.6	(1067)
	Pentane-1, 4, 5-triol-3-one oxime ($HO.CH_2.CHOH.C(NO.H).CH_2.CH_2.OH$)..	H_2O	3.28		11.8	
$C_6H_{11}ClN_2O_3$	Trihydroxypropylpyrazole hydrochloride§...	H_2O	9.74		-5.6†	(668)
$C_{10}H_{14}N_2O_4$	<i>d</i> -Erythronic acid phenylhydrazide.....	$H_2O?$	3.46	20	17.5	(1805)
$C_{10}H_{22}O_4$	2, 5-Dihydroxy-3, 4-dimethoxy-2, 5-dimethyl- hexane ($HO.C(CH_3)_2.CH(OCH_3).CH-$ ($OCH_3).CH(CH_3)_2.OH$).....	MeOH	3.5244	20	-30.9	(1747)
		Me_2CO	5.0884	20	-41.96	
$C_{17}H_{20}N_2O_3$	<i>d</i> -Erythrose benzylphenylhydrazone.....	EtOH	10.32	20	-32	(1805)
$C_{28}H_{26}O_4$	Tetraphenylerythritol.....	EtOH	4.33	20	182.8	(659)
HYDROXYAMINES						
$C_{10}H_{15}NO$	Ephedrine ($C_6H_5.CHOH.CH.(CH_3).NH.CH_3$)	EtOH	3.6	20	-6.3	(701); cf. (426.5)
	Pseudoephedrine.....	EtOH	4.07	20	51.2	
$C_{10}H_{16}ClNO$	Pseudoephedrine hydrochloride.....	H_2O	14.34	15	-33.8	(262)
$C_{12}H_{18}ClNO_2$	Acetyephedrine hydrochloride.....	H_2O	4.166	20	96.8	(262)
$C_{14}H_{16}NO$	α, β -Diphenyl- β -hydroxyethylamine†.....	$C_6H_6?$	3		± 109.7	(432)
$C_{14}H_{16}ClNO$	Hydrochloride.....	H_2O	1		± 80.23	(432)
$C_{16}H_{17}NO_2$	Acetyl- l - α, β -diphenyl- β -hydroxyethylamine	EtOH	1.26		-12.8	(432)
$C_{17}H_{20}N_2OS$	Ephedrylphenylthiocarbamide.....	EtOH	3.88	20	-105.1	(701)
	Pseudoephedrylphenylthiocarbamide.....	EtOH	4.16	20	22.8	
$C_{21}H_{19}NO$	Benzylidene- d - α, β -diphenyl- β -hydroxyethyl- amine.....	EtOH	1.40		+55	(432)
	Benzylidene- l - α, β -diphenyl- β -hydroxyethyl- amine.....	EtOH	1.47		-56	(432)
$C_{21}H_{19}NO_2$	Benzoyl- l - α, β -diphenyl- β -hydroxyethylamine	MeOH	1		± 29.0	(432)
DIAMINES						
$C_{10}H_{16}N_2$	<i>d</i> - <i>p</i> -Phenylenedi- α -ethylamine ($C_6H_4.(CH_2CH_2.NH_2)_2$).....	EtOH	4.82	22	18.15	(111)
$C_{17}H_{20}N_2S$	<i>d</i> -Diphenyldiethylthiocarbamide ($CS(NH.CH_2CH_2.C_6H_5)_2$).....	EtOH	1		22.5	(1284)
	<i>l</i> -Diphenyldiethylthiocarbamide.....	EtOH			-22.1	
$C_{18}H_{22}N_2S$	Methyl <i>l</i> -phenylethylimidophenylethyl- thiocarbamate ($C_6H_5.CH(CH_3).N:C-$ ($S.CH_3$). $NH.CH_2CH_2.C_6H_5$)	EtOH	4.15		96	(1532)
$C_{18}H_{23}ClN_2S$	Hydrochloride.....	EtOH	3.66		193	(1532)
$C_{18}H_{23}IN_2S$	Hydroiodide.....	EtOH	12.23		138	(1532)
$C_{18}H_{24}N_2$	<i>d</i> - β - γ -Di- <i>p</i> -tolylamino- <i>n</i> -butane.....	EtOH	3.35	20	100	(1456)
CARBOXYLIC ACIDS						
DIHALOGENO MONO- AND DICARBOXYLIC ACIDS						
$C_4H_4Br_2O_4$	<i>l</i> - α, β -Dibromosuccinic acid.....	AcOEt	5.788	13	-148	(1329); cf. (1328)
		H_2O	2.475	12.5	-62.2	
	<i>l</i> -Isodibromosuccinic acid.....	AcOEt	8.47		-118	(1328)
$C_6H_8Cl_2O_4$	Dimethyl α, β -dichlorosuccinate.....	$CHCl_3$	13.1	20	-66	(373)
$C_9H_8Cl_2O_2$	β -Phenyl- α, β -dichloropropionic acid ($C_6H_5.CHCl.CHCl.COOH$).....				66.5	(454)
$C_9H_8Br_2O_2$	β -Phenyl- α, β -dibromopropionic acid.....				-63.6	(454)
$C_{10}H_{10}Cl_2O_2$	Methyl β -phenyl- α, β -dichloropropionate....	EtOH			61.9	(454)
$C_{11}H_{12}Cl_2O_2$	Ethyl β -phenyl- α, β -dichloropropionate....	EtOH			64.1	(454)

* Mutarotation. † $[\alpha]_{D^{20}}$. ‡ $C_6H_5.CHOH.CH(NH_2).C_6H_5$. § $\begin{array}{c} N-NH \\ || \\ CH_2CH \end{array} > C.CHOH.CHOH.CH_2OH.HCl$.

DIHYDROXYDICARBOXYLIC ACIDS
Tartaric acids, its salts and esters

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _{<i>D</i>}	Lit.
C ₄ H ₆ O ₆	Lithium salt (anhyd.).....	H ₂ O	8.31	20	35.84	(1272)
	Thallium salt.....	H ₂ O	5	20	4.76	
	Thallium ammonium salt.....	H ₂ O	5	20	10.03	(1272)
		H ₂ O	20	20	7.56	
	Thallium antimony salt (monohydrate).....	H ₂ O	5	20	100.44	(1272)
		H ₂ O	20	20	99.64	
	Thallium hydrogen salt.....	H ₂ O	1	20	12.02	(1272)
	Thallium lithium salt (monohydrate).....	H ₂ O	5	20	9.46	(1272)
		H ₂ O	20	20	6.69	
	Thallium potassium salt.....	H ₂ O	5	20	10.06	(1897); <i>cf.</i> (1272)
		H ₂ O	20	20	8.17	
	Thallium sodium salt (tetrahydrate).....	H ₂ O	5	20	9.07	(1272)
		H ₂ O	20	20	6.49	
	Potassium arsenyl salt.....	H ₂ O	0.56	20	21.13	
	Sodium arsenyl salt.....	H ₂ O	3.36	20	20.64	
	Sodium borotartrate.....	H ₂ O	2.54	20	55.02	(1272)
		H ₂ O	10.15		71.5	
	Ammonium titanotartrate.....	H ₂ O	2.317	20	−40.1	(750)
		H ₂ O	0.1448	20	276.3	
C ₄ H ₄ O ₈ As ₂	Arsenyltartaric acid.....	H ₂ O	12.3	20	16.91	(1272)
C ₆ H ₁₄ N ₂ O ₆	Ethylenediamine tartrate.....	H ₂ O	8.4	18	29.2	(349)
		H ₂ O	2.1	18	29.4	
		H ₂ O	2	17	17.6	(2225)
C ₁₀ H ₁₂ NO ₆	Aniline hydrogen tartrate.....	H ₂ O	5	17	17.35	
		H ₂ O	10	17	17.54	
		H ₂ O	2	17	17.72	(2225)
C ₁₆ H ₂₀ N ₂ O ₆	Dianiline tartrate.....	H ₂ O	10	17	17.67	
		H ₂ O	35	16.5	14.56	(1378)
C ₆ H ₈ O ₆	Methyl hydrogen <i>d</i> -tartrate.....	H ₂ O	6.3	18	18.71	(445)
		H ₂ O	2.07		18.1	(445)
		EtOH	1.04		3.22	
	Ammonium salt.....	H ₂ O	2.29		28.0	(445)
	Calcium salt (pentahydrate).....	H ₂ O	22.5	20	17.80	(1378)
	Lithium salt.....	H ₂ O	2.15		26.5	(445)
	Potassium salt.....	H ₂ O	2.56		22.7	(445)
	Sodium salt.....	H ₂ O	2.35		21.0	(445)
	Methyl hydrogen mesotartrate.....	H ₂ O	9.2	17	−5.43	(1378)
	Ammonium salt.....	H ₂ O	6		−20.83	(1378)
C ₆ H ₁₀ O ₆	Ethyl hydrogen tartrate.....	H ₂ O	5		−7.3	(1378)
		H ₂ O	2.25		21.8	(445)
		EtOH	1.13		7.1	
	Barium salt.....	H ₂ O	3.11		20.3	(445)
	Calcium salt.....	H ₂ O	2.49		24.3	(445)
	Lithium salt.....	H ₂ O	2.33		28.8	(445)
	Potassium salt.....	H ₂ O	2.73		21.6	(445)
	Sodium salt.....	H ₂ O	2.53		27.5	(445)
	<i>l</i> -Bornyl hydrogen <i>d</i> -tartrate.....	EtOH	2.18	14.5	−5.7	(2218)
		EtOH	7.58	12	−6.5	
C ₁₄ H ₂₂ O ₆		Me ₂ CO	2.38		−1.26	
	<i>l</i> -Bornyl hydrogen <i>l</i> -tartrate.....	EtOH	2.99		−51.7	
	Di- <i>sec</i> -octyl tartrate.....		1.0195	18	7.06	(1320)
	Di- <i>l</i> -bornyl <i>d</i> -tartrate.....	CHCl ₃	2.03	13.5	−5.17	(2218)
		Me ₂ CO	2.28	14	−5.71	
		C ₆ H ₆	2.16	12	3.46	
	Di- <i>l</i> -bornyl <i>l</i> -tartrate.....	CHCl ₃	2.52	15	−71.4	
		C ₆ H ₆	2.42	14.5	−77.6	
		Me ₂ CO	2.54	11.5	−71.3	

Amides of tartaric acid

C ₄ H ₈ N ₂ O ₄	Tartramide.....	H ₂ O	1.31	20	106.5	(656)
		MeOH	0.180	20	144	
C ₆ H ₁₀ N ₂ O ₄	Tartaric dimethylamide.....	MeOH	4.99	20	148.8	(660)

Amides of tartaric acid.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₆ H ₁₀ N ₂ O ₄	Tartaric dimethylamide.—(<i>Cont'd</i>).....	Py	7.68	20	158.3	(656)
		H ₂ O	0.994	20	144.7	
C ₈ H ₁₆ N ₂ O ₄	Tartaric diethylamide.....	Py	5.03	20	136.6	(656)
		H ₂ O	7.47	20	125.5	
		H ₂ O	1.39	20	128.6	
		MeOH	5.00	20	137.9	(660)
C ₁₀ H ₁₆ N ₂ O ₄	Tartaric diallylamide.....	Py	4.74	20	110.7	(660)
		MeOH	5.9	20	118.4	
		H ₂ O	4.7	20	107.8	
C ₁₀ H ₂₀ N ₂ O ₄	Tartaric di- <i>n</i> -propylamide.....	MeOH	4.86	20	124.8	(660)
		H ₂ O	2.7	20	112.1	
		Py	4.74	20	123.9	
C ₁₀ H ₂₀ N ₂ O ₄	Tartaric diisopropylamide.....	Py	4.66	20	117.1	
		MeOH	1.91	20	117.8	
		H ₂ O	4.68	20	106.3	
C ₁₂ H ₁₂ N ₂ O ₆	Tartaric difurfurylamide.....	Py	4.88	20	99.4	(651)
C ₁₂ H ₂₄ N ₂ O ₄	Tartaric di- <i>n</i> -butylamide.....	Py	4.8	20	110.7	(660)
		MeOH	4.42	20	112.0	
		H ₂ O	0.258	20	107.5	
C ₁₂ H ₂₄ N ₂ O ₄	Tartaric diisobutylamide.....	Py	5.06	20	113.2	
		MeOH	5.43	20	117.2	
		H ₂ O	0.55	20	105.6	
C ₁₄ H ₁₄ N ₄ O ₆	Tartaric difurfurylidenehydrazide.....	Py	3.05	20	219.9	(656)
C ₁₄ H ₂₄ N ₂ O ₄	Tartaric dipiperidide.....	Py	3	20	0	(651)
		PhNH ₂	3	20	0	
C ₁₆ H ₁₄ Br ₂ N ₂ O ₄	Tartaric di- <i>o</i> -dibromoanilide.....	Py	6.604	20	142.3	(661)
		MeOH	3.363	20	118.3	
		MeOH	0.9402	20	120.9	
	Tartaric di- <i>m</i> -dibromoanilide.....	Py	4.835	20	189.3	
		MeOH	0.9862	20	154.5	
	Tartaric di- <i>p</i> -dibromoanilide.....	Py	4.908	20	193.2	
C ₁₆ H ₁₄ Cl ₂ N ₂ O ₄	Tartaric di- <i>o</i> -dichloroanilide.....	MeOH	0.1359	20	181.1	
		Py	5.060	20	192.1	(661)
		MeOH	1.524	20	164.3	
	Tartaric di- <i>m</i> -dichloroanilide.....	Py	4.966	20	223.4	
		MeOH	1.504	20	182.3	
	Tartaric di- <i>p</i> -dichloroanilide.....	MeOH	1.749	20	196	
C ₁₆ H ₁₆ N ₂ O ₄	Tartranilide.....	Py	4.81	20	227.2	
		Py	5.42	20	246.5	(656)
		MeOH	0.08	20	200	
C ₁₈ H ₁₈ N ₄ O ₄	Tartaric dibenzylidenehydrazide.....	Py	0.383	20	160.2	(656)
C ₁₈ H ₂₀ N ₂ O ₄	Tartaric dibenzylamide.....	Py	1.834	20	156.8	
		Py	5.50	20	91.5	(656)
C ₁₃ H ₂₀ N ₂ O ₄	Tartaric <i>o</i> -toluidide.....	Py	4.99	20	203	
C ₁₈ H ₃₆ N ₂ O ₄	Tartaric <i>m</i> -toluidide.....	Py	2.01	20	220	
		Py	3.58	20	88.72	(660)
		MeOH	0.995	20	88.14	
C ₂₀ H ₂₂ N ₄ O ₄	Tartaric di- α -methylbenzylidene hydroxide [(CHOH.CO.NH.N:C(C ₆ H ₅)CH ₃) ₂	Py	0.747	20	104	(656)
C ₂₄ H ₂₀ N ₂ O ₄	Tartaric di- α -naphthylamide.....	Py	6.56	20	100.3	(656)
		Py	1.32	20	292	
C ₂₄ H ₂₈ N ₂ O ₄	Tartaric di- <i>ar</i> -tetrahydro- β -naphthylamide..	Py	4.43	20	205.9	(651)
		Py	2.17	20	58.4	
<i>Imides of tartaric acid</i>						
C ₆ H ₇ NO ₄	Tartaric methylimide (partly racemized)....	H ₂ O	19.94		192.6	(1152)
C ₆ H ₉ NO ₄	Tartaric ethylimide.....	H ₂ O	8.57		166.2	(1152)
C ₁₀ H ₉ NO ₄	Tartranil.....	H ₂ O	0.596	20	114	(656)
		MeOH	1.64	20	130	
		Py	4.76	20	132	
C ₁₁ H ₁₁ NO ₄	Tartaric <i>p</i> -toluil.....	MeOH	1.98	20	118.3	(656)
		Py	6.32	20	165.6	
<i>Diacyltartaric acids and derivatives</i>						
C ₈ H ₁₀ O ₈	Diacytl- <i>d</i> -tartaric acid.....	H ₂ O	17.95	22	-23.04	(1638)
		H ₂ O	3.76	22	-19.32	

Diacyltartaric acids and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₈ H ₁₀ O ₈	Diacetyl- <i>d</i> -tartaric acid.—(<i>Cont'd</i>).....	EtOH	7.37	22	−23.63	
		MeOH	4.68	22	−23.74	
C ₈ H ₈ O ₇	Diacetyl- <i>d</i> -tartaric anhydride.....	C ₆ H ₈	2.09		63.05	(1638)
		C ₆ H ₆	1.45		58.69	
		Me ₂ CO	11.66		59.70	
		Me ₂ CO	4.40		62.04	
C ₁₀ H ₁₄ O ₈	Dimethyl diacetyl- <i>d</i> -tartrate.....	EtOH	3.57	18	−14.23	(1638)
C ₁₀ H ₁₈ N ₂ O ₈	Ethylenediamine diacetyl- <i>d</i> -tartrate.....	H ₂ O		11.5	−12.74	(1638)
	Acid salt.....	H ₂ O		11.5	−17.05	
C ₁₂ H ₁₈ O ₈	Diethyl diacetyl- <i>d</i> -tartrate.....	EtOH	23.64	17	1.02	(678)
		EtOH	7.85	14	7.04	
C ₁₄ H ₂₂ O ₈	Di- <i>n</i> -propyl diacetyl- <i>d</i> -tartrate.....	EtOH	3.25	15	6.52	(1638)
C ₁₆ H ₂₈ O ₈	Di- <i>n</i> -butyl diacetyl- <i>d</i> -tartrate.....		3.25	20	17.8	(678)
		EtOH	13.56	14	10.5	
	Diisobutyl diacetyl- <i>d</i> -tartrate.....	EtOH	7.95	15	10.3	(678, 1638)
C ₂₂ H ₂₄ N ₂ O ₆	Diacetyltartaric <i>d</i> -toluidide.....	Py	5.24	20	19.61	(656)
<i>Halogenoacetyltartrates</i>						
C ₈ H ₉ Cl ₃ O ₇	Dimethyl monotrichloroacetyltartrate.....	PhNO ₂	4.75	48.7	7.10	(1576)
C ₁₀ H ₈ Cl ₆ O ₈	Dimethyl ditrichloroacetyltartrate.....	PhNO ₂	4.9	20	−3.3	(1576)
		PhNO ₂	4.9	14	−3.41	
		PhNO ₂	4.9	41.5	−2.75	
C ₁₂ H ₁₂ Cl ₆ O ₈	Diethyl ditrichloroacetyltartrate.....			20	13.49	(1576)
				53	13.23	
				70.7	13.35	
C ₁₈ H ₂₀ Cl ₆ O ₈	Diisobutyl ditrichloroacetyltartrate.....			20	16.65	(1576)
				157	16.12	
		PhNO ₂	5.03	20	9.49	
		PhNO ₂	5.03	91.9	11.55	
		PhNO ₂	4.75	20	7.83	
<i>Mono- and dibenzoyltartaric acids and derivatives</i>						
C ₁₆ H ₁₇ NO ₉	Diethyl mono- <i>m</i> -nitrobenzoyltartrate.....	EtOH	2.38	20	12.50	
		AcOEt	4.97	20	26.52	
		AcOEt	2.69	20	29.77	
		CHCl ₃	4.04	20	14.26	
		C ₆ H ₈	2.999	20	0	
		Py	9.00	20	4.64	
C ₁₆ H ₁₈ O ₇	Diethyl monobenzoyltartrate.....			24	20.7	(647, 622)
				63	19.02	
				99.5	17.69	
				135	16.36	
C ₁₆ H ₁₉ NO ₉	Diethyl mononitro- <i>p</i> -toluyltartrate.....	EtOH	2.63	20	7.02	(644)
		AcOEt	8.93	20	19.85	
		CHCl ₃	7.66	20	16.74	
		C ₈ H ₈	3.88	20	−10.86	
		Py	7.05	20	−20.51	
C ₁₆ H ₂₀ O ₇	Diethyl mono- <i>o</i> -toluyltartrate.....			14	12.08	(647, 662)
				32.5	11.74	
				100	10.88	
				136.5	10.62	
C ₁₈ H ₁₂ O ₇	Dibenzoyltartaric anhydride.....	Me ₂ CO	4.644	18	142.94	(1638)
		Me ₂ CO	1.572	18	143.2	
C ₁₈ H ₁₄ O ₈ ·H ₂ O	Dibenzoyltartaric acid.....	EtOH	8.933	17	−110.91	(1638)
		EtOH	4.994	15	−112.05	
		MeOH	4.857	19	−116.30	
		EtOH	8.506	17	−116.47	
	Anhydrous.....	EtOH	4.755	15	−117.68	
		MeOH	4.625	19	−122.14	
C ₂₀ H ₁₆ N ₂ O ₁₂	Dimethyl di- <i>o</i> -nitrobenzoyltartrate.....		1.3484	100	−97.97*	(643)
		C ₈ H ₆	0.856	11	−184.9	
	Dimethyl di- <i>m</i> -nitrobenzoyltartrate.....		1.3760	22	−79.36	(643)
			1.3484	100	−69.22	
			1.3236	179.5	−53.37	

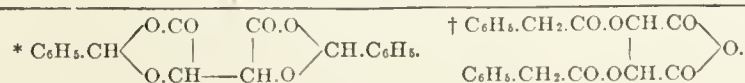
* Calculated from density of the *m*-compound.

Mono- and dibenzoyltartaric acids and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₂₀ H ₁₆ N ₂ O ₁₂	Dimethyl di- <i>p</i> -nitrobenzoyltartrate.....		1.3260	100	-107.56	(643)
			1.2923	136	-92.96	
			1.2531	178	-77.11	
C ₂₀ H ₁₈ O ₈	Dimethyl dibenzoyltartrate.....			100	-72.56	(647, 622)
		EtOH	0.245	20	-96.61	(1638)
		CHCl ₃	11.61	19	-88.24	
C ₂₂ H ₂₂ O ₈	Diethyl dibenzoyltartrate.....	EtOH	9.175	16	-54.50	(1638)
		EtOH	2.69		-60.02	
				18	-59.36	(647, 662)
C ₂₂ H ₂₀ N ₂ O ₁₂	Diethyl di- <i>o</i> -nitrobenzoyltartrate.....		1.3720	15	-131.85	(643)
			1.2794	100	-62.66	
			1.2412	135	-42.64	
			1.1968	179	-23.71	
	Diethyl di- <i>m</i> -nitrobenzoyltartrate.....		1.3449	20	-70.90	
			1.2679	100	-64.35	
			1.1900	181	-49.08	
	Diethyl di- <i>p</i> -nitrobenzoyltartrate.....		1.3377	13	-129.3	
			1.2648	99	-97.57	
			1.2329	135	-85.47	
C ₂₆ H ₃₀ O ₈	Diisobutyl dibenzoyltartrate.....		1.1898	181	-67.83	
		EtOH	14.08	22	-48.86	(1638)
		EtOH	2.88	19	-41.95	
C ₂₈ H ₃₄ O ₈	Ethyl octyl dibenzoyltartrate.....		1.0956	10.8	49.41	(1319)
C ₃₄ H ₄₆ O ₈	Di- <i>sec</i> .-octyl dibenzoyltartrate.....		1.0913	25	-43.94	(1320)
<i>Nitrotartaric acid and derivatives</i>						
C ₄ H ₄ N ₂ O ₁₀	Dinitrotartaric acid.....	MeOH	0.99	20	16.48	(645)
		MeOH	9.09	20	13.70	
		EtOH	9.09	20	13.48	
C ₆ H ₈ N ₂ O ₁₀	Dimethyl dinitrotartrate.....	EtOH	2.42	20	27.54	(2099)
		MeOH	8.38	20	20.28	(645)
		EtOH	8.60	20	13.36	
		C ₆ H ₆	8.02	20	19.42	
		C ₆ H ₆	1.09	20	23.63	
		MeOH	4.92	20	27.43	(645)
C ₆ H ₉ NO ₈	Dimethyl mononitrotartrate.....	EtOH	9.09	20	27.36	
		C ₆ H ₆	1.77	20	16.53	
		MeOH	2.21		29.87	(2099)
C ₈ H ₁₂ N ₂ O ₁₀	Diethyl dinitrotartrate.....		1.307 ₂₀		27.10	
		MeOH	8.87	20	27.18	(645)
		EtOH	8.64	20	24.27	
		C ₆ H ₆	9.39	20	23.76	
		MeOH	8.91	20	35.55	(645)
		EtOH	8.53	20	34.44	
C ₈ H ₁₃ NO ₈	Diethyl mononitrotartrate.....	C ₆ H ₆	8.46	20	31.31	
			1.2088 ₂₀		30.86	(2099)
<i>Dimethoxysuccinic acid and derivatives</i>						
C ₆ H ₈ Cl ₂ O ₄	<i>d</i> -Dimethoxysuccinyl chloride.....	Me ₂ CO	5.3913	20	79.85	(1747)
		CHCl ₃	1.2484	20	56.87	
		C ₆ H ₆	2.0357	20	104.14	
C ₆ H ₈ O ₅	<i>d</i> -Dimethoxysuccinic anhydride.....	Me ₂ CO	5.2573	20	148.7	(1747)
		Me ₂ CO	2.3148	20	148.4	
		Me ₂ CO	1.6324	20	235.54	(2224)
C ₆ H ₉ NO ₄	<i>d</i> -Dimethoxysuccinimide.....	H ₂ O	1.6244	20	178.53	
		EtOH	1.6168	20	241.22	
		H ₂ O	1.3016	20	89.89	(2224)
C ₆ H ₁₁ NO ₅	<i>d</i> -Dimethoxysuccinamic acid.....	H ₂ O	1.8896	20	88.11	
		EtOH	1.1648	20	103.45	
		H ₂ O	0.72	20	94.44	(1732)
C ₆ H ₁₂ N ₂ O ₄	<i>d</i> -Dimethoxysuccinamide.....	H ₂ O	1.1516	20	130.25	(2224)
C ₆ H ₁₄ N ₄ O ₄	<i>d</i> -Dimethoxysuccinic hydrazide.....	H ₂ O	4.3692	20	128.28	
C ₇ H ₁₁ NO ₄	<i>d</i> -Dimethoxysuccinic methylimide.....	Me ₂ CO	1.2500	20	228.8	(2224)
C ₇ H ₁₂ O ₆	Methyl hydrogen <i>d</i> -dimethoxysuccinate....	Me ₂ CO	4.615	20	91.22	(1747)
		H ₂ O	4.823	20	69.35	
		H ₂ O				
C ₁₂ H ₁₃ NO ₄	<i>d</i> -Dimethoxysuccinanil.....	Me ₂ CO	1.1228	20	198.16	(1732)
		Me ₂ CO	2.2824	20	197.16	

Dimethoxysuccinic acid and derivatives.—(Continued)

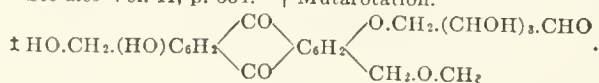
Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₂ H ₁₅ NO ₆	<i>d</i> -Dimethoxysuccinic monoanilide.....	Me ₂ CO	1.2696	20	129.57	(2224)
		EtOH	1.1560	20	128.03	
C ₁₂ H ₂₂ O ₆	Propyl <i>d</i> -dimethoxysuccinate.....	Me ₂ CO	2.2816	20	129.51	(1732)
			1.0612	20	84.92	
			1.0237	60	81.06	
C ₁₈ H ₂₀ N ₂ O ₄	<i>d</i> -Dimethoxysuccinanilide.....	Me ₂ CO	1.198	20	255.43	(2224)
		Me ₂ CO	1.880	20	254.79	
		EtOH	1.1496	20	227.03	
<i>Diethoxysuccinic acid and derivatives</i>						
C ₈ H ₁₂ O ₆	<i>d</i> -Diethoxysuccinic anhydride.....	Me ₂ CO	1.6328	20	143.62	(2224)
		Me ₂ CO	6.1416	20	143.85	
C ₈ H ₁₄ O ₆	<i>d</i> -Diethoxysuccinic acid.....	Me ₂ CO	1.3680	20	84.06	(2224)
		Me ₂ CO	2.2008	20	83.66	
C ₈ H ₁₈ N ₄ O ₄	<i>d</i> -Diethoxysuccinic hydrazide.....	H ₂ O	1.2832	20	123.13	(2224)
		H ₂ O	1.8808	20	124.95	
		H ₂ O	4.0960	20	125.61	
C ₁₀ H ₁₈ O ₆	Dimethyl <i>d</i> -diethoxysuccinate.....			20	89.28	(2224)
		H ₂ O	3.962	20	79.00	
C ₁₄ H ₁₇ NO ₄	<i>d</i> -Diethoxysuccinanil.....	Me ₂ CO	3.8864	20	182.56	(2224)
		EtOH	2.2864	20	180.19	
		C ₆ H ₆	2.1336	20	237.39	
C ₁₄ H ₁₉ NO ₆	<i>d</i> -Diethoxysuccinic monoanilide.....	Me ₂ CO	2.4488	20	143.54	(2224)
		EtOH	2.4712	20	137.18	
C ₂₀ H ₂₄ N ₂ O ₄	<i>d</i> -Diethoxysuccinic dianilide.....	Me ₂ CO	1.180	20	263.14	(2224)
		Me ₂ CO	1.6984	20	267.60	
		Me ₂ CO	2.1812	20	278.06	
<i>Other tartaric acid derivatives with one or both of the hydrogen atoms of the hydroxyl groups substituted</i>						
C ₅ H ₆ O ₆	Monomethylene- <i>d</i> -tartaric acid; cf. (1262)...	H ₂ O	0.8		-73	(1262.5)
C ₅ H ₈ O ₆	α -Hydroxy- β -methoxysuccinic acid.....	H ₂ O	1.85		45.4	(837)
C ₁₈ H ₁₄ O ₆	Dibenzylidene- <i>d</i> -tartaric acid*.....	MeOH			128	(422)
C ₁₈ H ₁₄ O ₆	Di- <i>p</i> -tolylidene- <i>d</i> -tartaric acid.....	MeOH			107	
C ₁₈ H ₁₈ O ₁₀	Diethyl dipyromucyltartrate.....		1.1914	99.5	-67.65	(634)
			1.1524	140	-60.55	
		EtOH	0.503	20	-98.54	
		EtOH	4.94	20	-86.82	
C ₂₀ H ₁₆ O ₇	Diphenacyltartaric anhydride†.....				58	(677)
C ₂₂ H ₂₀ O ₇	Diphenylpropionyltartronic anhydride (C ₆ H ₅ .CH ₂ .CH ₂ .CO.O.CH.CO) ₂ O.....				38	(677)
<i>Sulfur derivatives of tartaric acid</i>						
C ₆ H ₈ O ₇ S	Dimethyl thionyltartrate.....		1.4445 ^{19.5} _{19.5}	18	-61	(1871)
C ₇ H ₁₀ O ₅ S ₂	<i>d</i> -Xanthosuccinic acid.....	EtOH	5.20	17	82.8	
	(HO.CO.CH(S.CS.OC ₂ H ₅)CH ₂ .COOH)	AcOEt	2.69	17	101.7	(917)
	<i>l</i> -Xanthosuccinic acid.....	AcOEt	5.48	17	-101.6	
C ₈ H ₁₀ O ₈ S ₂	Dithiosuccinic acid.....	EtOH	5	17	272.8	(920.2)
		Me ₂ CO	5	17	270.2	
		H ₂ O	5	17	290.5	
		H ₂ O	5.07	17	68.1	
C ₈ H ₁₂ O ₇ S	Diethyl thionyltartrate.....		1.3257 ^{19.5} _{19.5}	18	-56.7	(1871)
			1.329	19.5	-183.8	(1330)
			1.342	9.5	-185.4	
C ₁₀ H ₁₆ O ₇ S	Di- <i>n</i> -propyl thionyltartrate.....		1.2382	18	-18.54	(1871)
<i>Other hydroxycarboxylic acids and derivatives</i>						
C ₄ H ₈ O ₄	<i>l</i> - α , β -Dihydroxybutyric acid.....	H ₂ O	5.99	16	-13.51	(1462)
	Barium salt.....	H ₂ O	6.27	16	-20.63	(1462)
C ₅ H ₈ O ₆	<i>d</i> - α , γ -Dihydroxyglutaric acid.....	H ₂ O	0.668		3.9	(1065)
C ₆ H ₁₀ O ₆	<i>d</i> - α , α' -Dihydroxyadipic acid.....	H ₂ O?	6.16	16	3.8	(1201)
	Ammonium salt.....	H ₂ O	6.16	16	-21.4	(1201)
C ₉ H ₁₀ O ₄	<i>l</i> -Phenylglyceric acid.....	H ₂ O	3.16	20	-39.63	(1782)
	(C ₆ H ₅ .CHOH.CHOH.COOH)	98% EtOH	6.28	20	-30.48	
		Me ₂ CO	7.36	20	-36.43	



Other hydroxycarboxylic acids and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₀ H ₁₄ N ₂ O ₄	<i>l</i> -Threonyl phenylhydrazide (HO.CH ₂ -. CHOH.CHOH.CO.NH.NH.C ₆ H ₅).....	H ₂ O	4.75	20	-26.88	(1490)
C ₁₄ H ₂₈ O ₄	Ipurolic acid (C ₁₃ H ₂₅ (OH) ₂ .COOH).....	EtOH	13.0		0	(1705)
C ₁₆ H ₃₀ O ₄	Methyl ipuroate (C ₁₃ H ₂₅ (OH) ₂ CO.OCH ₃)...	EtOH	3.45		1.69	(1705)
C ₁₈ H ₃₆ O ₄	<i>d</i> -θ-λ (9,12)-Dihydroxystearic acid (CH ₃ - (CH ₂) ₅ .CHOH(CH ₂) ₂ .CHOH(CH ₂) ₇ -. COOH).....	EtOH	4.3		6.45	(757)
IB ₃ to IB _n . CARBOHYDRATES AND RELATED COMPOUNDS*						
SUGARS CONTAINING 5 CARBON ATOMS AND RELATED COMPOUNDS						
Methyltetroses						
C ₅ H ₁₀ O ₄	Methyltetrose (CH ₃ (CHOH) ₃ .CHO).....	9.6% EtOH	9.47		-16.35†	(1807)
C ₅ H ₈ O ₄	Methyltetronic lactone.....	H ₂ O	5.9	20	-47.5	(1807)
C ₅ H ₁₂ O ₅	α-Glucodesose (2-Desoxyglucose (5 min.)... (5 after min.).....	Py H ₂ O	4.16 9.21	19 19	90.11† 46.52	(112)
	β-Glucodesose (H(CHOH) ₃ .CH ₂ .CHO) (after 5 min.)..... (after 5 min.)..... (after 24 hr.).....	H ₂ O Py	9.50 2.03	18 18	46.59† 15.03 90.21	
C ₂₇ H ₂₃ BrO ₇	Tribenzoylbromoglucodesose.....	C ₂ H ₂ Cl ₄	4.49	16	121.4	(112)
C ₂₇ H ₂₄ O ₈	Tribenzoylglucodesose.....	C ₂ H ₂ Cl ₄	5.18	19	38.39	(112)
C ₂₈ H ₂₆ O ₈	Tribenzoylmethylglucodesoside.....	C ₂ H ₂ Cl ₄	8.63	19	-34.31	(112)
C ₃₄ H ₂₈ O ₉	Tetrabenzoylglucodesose.....	C ₂ H ₂ Cl ₄	9.32	16	8.96	(112)
Arabinose and derivatives						
C ₅ H ₁₀ O ₅	<i>d</i> -Arabinose } <i>cf.</i> (95.5 1061, 1558, 1862.5, <i>l</i> -Arabinose } 2206) (H(CHOH) ₄ .CHO).....	H ₂ O H ₂ O	10.11 10	20 18	-104.1† 104.4	(2205) (1258, 1860)
C ₅ H ₁₃ NO ₄	Arabinamine (H(CHOH) ₄ .CH ₂ .NH ₂).....	H ₂ O	5.46	15	-4.58	(1803, 1804)
C ₆ H ₁₂ O ₆	α-Methylarabinoside..... β-Methylarabinoside.....	H ₂ O H ₂ O	10.01 8.16	20 20	245.7 73.24	(1741)
C ₆ H ₁₃ N ₃ O ₅	Arabinose semicarbazone.....	H ₂ O	40		23.8†	(1375)
C ₇ H ₁₀ Cl ₂ O ₅	Dechloroarabinoehloralose.....	H ₂ O		15	-19.72	(826)
C ₈ H ₁₆ O ₅	2, 3, 4-Trimethylarabinose.....	H ₂ O	7.98	20	127.2	(1741)
C ₉ H ₁₈ O ₅	2, 3, 4-Trimethyl-α-methylarabinoside.....	H ₂ O	9.9	20	250.8	(1741)
C ₁₁ H ₁₅ BrO ₇	Triacetyl bromo- <i>l</i> -arabinose; <i>cf.</i> (287).....	MeOH	12.13	20	223.1	
C ₁₁ H ₁₅ ClO ₇	Triacetyl chloro- <i>l</i> -arabinose; <i>cf.</i> (287).....	CHCl ₃	1.86	20	287.11	(233)
C ₁₁ H ₁₅ FO ₇	Triacetyl fluoro- <i>l</i> -arabinose.....	CHCl ₃	2.4	20	244.4	(233)
C ₁₁ H ₁₅ IO ₇	Triacetyl iodo- <i>l</i> -arabinose.....	CHCl ₃	2.4	20	138.18	(233)
C ₁₂ H ₂₈ N ₂ O ₁₂	Arabinamine oxalate.....	CHCl ₃ H ₂ O	2.5 5	20 15	339.06 -13.5	(233) (1803, 1804)
C ₁₇ H ₁₈ O ₄	Anhydro-1, 1-diphenylarabitol.....	Me ₂ CO	1.37	8	114.8	(1550)
C ₁₇ H ₂₀ N ₂ O ₄	<i>l</i> -Arabinose diphenylhydrazone.....	Py	1.05		14.9	(1480)
C ₁₇ H ₂₀ N ₄ O ₃	Arabinososazone (initial rotation); <i>cf.</i> (455).	EtOH	3.4	20	18.90†	(25)
C ₁₇ H ₂₀ O ₆	1-1, Diphenyl- <i>l</i> -arabitol (HO.C(C ₆ H ₅) ₂ .(CHOH) ₃ .CH ₂ OH).....	H ₂ O	0.4075	20	85.6	(1550)
C ₁₉ H ₁₈ O ₅	Dibenzylidenearabinose.....	MeOH	0.4		26.8	(421)
C ₁₉ H ₂₄ O ₅	α, α-Dibenzyl- <i>l</i> -arabitol.....	EtOH	0.2689	19	31.5	(1550)
C ₁₉ H ₂₄ O ₅	α, α-Di- <i>p</i> -tolyl- <i>l</i> -arabitol.....	EtOH	0.5491	18	71.62	(1550)
C ₂₁ H ₂₂ O ₅	Di- <i>p</i> -tolylidenearabinose.....	CHCl ₃	0.4		2.9	(421)
C ₂₂ H ₂₂ O ₁₀	β-Homonataloin†..... γ-Homonataloin..... δ-Homonataloin.....	60% EtOH 60% EtOH 60% EtOH	1 1 1		0 -146.2 110.6	(1189)
C ₂₃ H ₂₄ O ₁₀	Nataloin (natural)..... β-Nataloin..... γ-Nataloin..... δ-Nataloin.....	60% EtOH 60% EtOH 60% EtOH 60% EtOH	1 1 1 1		-145 10 -143.7 -146	(1189)
C ₃₂ H ₃₂ O ₁₅	γ-Pentaacetylhomonataloin.....	EtOH			-54.2	
C ₃₃ H ₃₄ O ₁₅	γ-Pentaacetylnataloin..... δ-Pentaacetylnataloin.....	EtOH AcOH EtOH			-53 -58 -56.1	(1189)

* See also Vol. II, p. 334. † Mutarotation.



Xylose and derivatives

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₅ H ₁₀ O ₅	<i>d</i> -Xylose (equilibrium).....	H ₂ O	9.937	20	-18.6*	(542)
	<i>l</i> -Xylose (after 24 hours).....	H ₂ O	3.115	20	18.42*	(1911)
		H ₂ O	5.376	20	18.55*	
		H ₂ O	9.706	20	18.77*	
		H ₂ O	21.744	20	19.61*	
		H ₂ O	34.355	20	20.49*	
		H ₂ O	46.395	20	21.43*	
		H ₂ O	56.229	20	22.68*	
		H ₂ O	61.747	20	23.70*	
		H ₂ O	10.664	20	19.22*	(1558); cf. (2173)
C ₅ H ₁₀ O ₅	α- <i>l</i> -Xylose (initial).....	H ₂ O			9.2†	(1991)
	(equilibrium).....	H ₂ O			18.5†	(1991)
C ₅ H ₁₁ NO ₄	Xylosimine (after 63 hr.) (H(CHOH) ₄ .CH: NH).....	H ₂ O	4.778		-15.9*	(1220)
	(after 24 hr.).....	H ₂ O	4.804		-15.71*	
C ₅ H ₁₃ NO ₄	Xylosamine (H(CHOH) ₄ .CH ₂ .NH ₂).....	H ₂ O	5.28	15	-8.52	(1803, 1804)
C ₅ H ₁₄ INO ₄	Xylosamine hydroiodide.....	H ₂ O	8	15	-12.50	(1803, 1804)
C ₅ H ₁₂ O ₅	Monomethyl- <i>l</i> -xylose (equilibrium).....	H ₂ O			42†	(1991)
C ₅ H ₁₃ N ₃ O ₅	Xylose semicarbazone.....	H ₂ O	40		24.4*	(1375)
C ₇ H ₁₄ O ₅	Dimethyl- <i>l</i> -xylose (equilibrium).....	H ₂ O			24†	(1991)
C ₈ H ₁₄ O ₅	Isopropylidene- <i>l</i> -xylose.....	H ₂ O			-19†	(1991)
C ₉ H ₁₆ O ₅	1, 2- <i>sec</i> .-Butylidene xylose ether.....	H ₂ O	6.04		-8.0†	(1993)
	Monomethylisopropylidenexylose.....	H ₂ O	0.568	18	-21.4†	(1991)
C ₁₀ H ₁₈ O ₅	Dimethylisopropylidenexylose.....	H ₂ O	2.34	18	-43.3†	(1991)
C ₁₁ H ₁₅ BrO ₇	Triacetyl bromoxylose.....	CHCl ₃	2.54	20	212.2	(365)
C ₁₁ H ₁₅ FO ₇	Triacetyl fluoroxylose.....	CHCl ₃	3.0	20	67.24	(231)
C ₁₁ H ₁₅ O ₈	Triacetyl-β-xylose.....	CHCl ₃		20	-24.9	(365)
C ₁₂ H ₁₈ O ₈	Triacetyl-β-methylxyloside.....	CHCl ₃	2.70	20	-60.8	(365)
C ₁₂ H ₂₀ O ₅	1, 2- <i>sec</i> .-Butylidene-4, 5(?)-isopropylidene-xylose.....	H ₂ O	1.22		15.7	(1993)
C ₁₂ H ₂₀ O ₅	1, 2-Isopropylidene-4, 5(?)- <i>sec</i> .-butylidene-xylose.....	H ₂ O	0.79		16.1†	(1993)
C ₁₃ H ₂₂ O ₅	1, 2, 4, 5(?) -Di- <i>sec</i> .-butylidenexylose.....	H ₂ O	0.51		17.4*	(1993)
C ₁₇ H ₂₀ N ₄ O ₃	Xylosazone.....	EtOH	2.815		-43.36	(455)
C ₁₉ H ₁₈ O ₅	Dibenzylidenexylose.....	MeOH	0.4		37.5	(421)
C ₂₁ H ₂₂ O ₅	Di- <i>p</i> -toluylidenexylose.....	Me ₂ CO			45.6	(421)
Other pentoses						
C ₅ H ₁₀ O ₅	Cyclose.....	H ₂ O		20	48.78	(1656)
C ₂₅ H ₄₂ O ₁₂	Cyclamin.....	H ₂ O?	2	20	-36.3	(1656)
C ₅ H ₁₀ O ₅	<i>l</i> -Ribose.....	H ₂ O	1.5		18.8*	(425)
C ₁₇ H ₁₈ Br ₂ N ₄ O ₃	<i>d</i> -Ribose <i>p</i> -bromophenylosazone.....	EtOH	0.998		-16	(1230)
C ₁₁ H ₁₆ N ₂ O ₄	Carnose phenylhydrazine.....	EtOH	3.77	20	4.53	(1229)
C ₁₁ H ₁₆ BrN ₂ O ₄	Carnose <i>p</i> -bromophenylhydrazine.....	EtOH	4.05	20	-5.69	(1229)
C ₁₈ H ₂₂ N ₂ O ₄	<i>d</i> -Lyxose benzylphenylhydrazine.....	EtOH	4.89		26.39	(1808)
Acids derived from pentoses						
C ₅ H ₈ O ₅	Arabonic lactone.....	H ₂ O	9.45	20	-73.9	(533)
	Strontium salt of arabonic acid (<i>C</i> at 100°C).....	H ₂ O	4.353	20	1.96	(26)
C ₅ H ₈ O ₅	Ribonic lactone.....	H ₂ O	9.34	20	-18.0	(533)
	Cadmium salt of ribonic acid.....	H ₂ O		20	0.6	(533)
C ₅ H ₈ O ₅	Lyxonic acid lactone.....	H ₂ O	9.78	20	82.4	(494)
C ₅ H ₈ O ₇	<i>l</i> -Trioxylglutaric acid.....	H ₂ O	9.59	20	-22.7	(2184)
	Potassium salt.....	H ₂ O	10.863	16	9.35	(2184)
(C ₅ H ₉ O ₆) ₂ Sr.6H ₂ O	Strontium xylonate (<i>C</i> at 100°C).....	H ₂ O	4.305	20	12.14	(26)
C ₇ H ₁₀ O ₆	Dimethylenexyonic acid.....	H ₂ O	7.5		39.2	(334)
C ₁₁ H ₁₄ O ₈	Triacetyl- <i>l</i> -arabonic lactone†.....	C ₆ H ₆	1.8584	18.5	-60.5	(1550)
C ₁₇ H ₁₅ O ₆	1, 1-Diphenyl-2, 3, 4-trihydroxytetrahydrofurfurane-4-carboxylic acid§.....	EtOH	1.1869	14	119.5	(1550)
		EtOH	1.345	17	201.7	

* Mutarotation. † [α]₇₅₀₀. ‡ CH₃.CO.O.CH₂.CH.CH(O.CO.CH₃).CH(O.CO.CH₃).CO. § C(C₆H₅)₂.CHOH.CHOH.CO.H.CO.H.

PENTAHYDRIC AND HEXAHYDRIC ALCOHOLS CONTAINING 6 CARBON ATOMS

Mannitol and derivatives

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₆ H ₈ Cl ₄ O ₄ S	Mannitol tetrachlorohydrine sulfate.....	C ₂ H ₂ Cl ₄	5.12	15	105.1	(848)
C ₈ H ₁₈ O ₆	5, 6-Dimethylmannitol.....	H ₂ O	2.47	20	-7.35	(979, 980)
		EtOH	2.47	20	-8.85	
C ₁₀ H ₂₂ O ₆	1, 2, 3, 4-Tetramethylmannitol.....	H ₂ O	2.49	20	22.1	(979, 980)
		EtOH	1.74	20	39.8	
	3, 4, 5, 6-Tetramethylmannitol.....	H ₂ O	1.92	20	-13.02	
		EtOH	1.81	20	-12.54	
C ₉ H ₁₈ O ₆	Isopropylidenemannitol.....	H ₂ O	2.76	20	26.4	(979, 980); cf. (465.5)
		EtOH	2.63	20	23.2	
C ₁₂ H ₂₂ O ₆	Diisopropylidenemannitol.....	H ₂ O	2.69	20	19.31	(979, 980); cf. (465.5)
		EtOH	2.70	20	15.75	
C ₁₄ H ₂₆ O ₆	Dimethyldiisopropylidenemannitol.....	H ₂ O	2.57	20	25.7	(979, 980)
		EtOH	2.08	20	21.9	
C ₂₄ H ₃₀ O ₁₀	Tetrabenzoylmannitol.....	C ₂ H ₂ Cl ₄	7.46	18	7.83	(487)
C ₃₇ H ₃₄ O ₁₀	Tetrabenzoylisopropylidenemannitol.....	C ₂ H ₂ Cl ₄	9.7	20	0.60	(487)
		PhMe	10.15	20	15.43	
C ₄₈ H ₃₈ O ₁₂	Hexabenzoylmannitol.....	CHCl ₃	2.119		50.7	(1701)
C ₆₀ H ₆₀ O ₁₂	Hexacinnamylmannitol.....	CHCl ₃	8.16	21	12.96	(528)
		CHCl ₃	7.57	20	13.15	

Dulcitol

C ₁₈ H ₂₀ O ₆	Anhydro- α , α -diphenyldulcitol					
	Hydrated.....	H ₂ O	0.98	20	-108.6	(1547)
	Anhydrous.....	H ₂ O	2.14	20	-82.1	
C ₁₈ H ₂₂ O ₆	1, 1-Diphenyldulcitol					
	(HO.C(C ₆ H ₅) ₂ .(CHOH) ₄ .CH ₂ OH).....	H ₂ O	0.3	20	72.9	(1547)
		EtOH	0.3	20	56.2	
		AcOEt	0.35	20	76.4	
C ₂₀ H ₂₆ O ₆	1, 1-Dibenzoyldulcitol.....	EtOH	0.26	20	1.46	
C ₂₈ H ₃₂ O ₁₁	1, 1-Diphenyl-2, 3, 4, 5, 6-pentaacetyldulcitol	EtOH	0.69	20	14.6	(1547)
C ₃₂ H ₃₀ O ₈	1, 1-Diphenyldibenzoyldulcitol.....	EtOH	0.467	18	64.7	(1547)

Sorbitol, sorbieritol and other isomerides of mannitol

C ₆ H ₁₄ O ₆	2-Desoxysorbitol (H(CHOH) ₃ .CH ₂ .CH ₂ .OH)	H ₂ O	9.11	18	15.61	(112)
C ₆ H ₁₄ O ₆	Sorbieritol (<i>d</i> -iditol).....	H ₂ O	10	20	-3.53	(127)
C ₆ H ₁₄ O ₆	<i>l</i> -Iditol.....	H ₂ O	10	20	-3.5	(133)
C ₆ H ₁₄ O ₆	<i>d</i> -Talitol.....	H ₂ O	10	18	3.05	(131)
C ₁₀ H ₂₂ O ₆	Tetramethylsorbitol.....	H ₂ O	1.463		-6.2	(962)
C ₁₂ H ₂₂ O ₆	Diisopropylidene- β -desoxysorbitol.....	C ₂ H ₂ Cl ₄	1.20	20	11.08	(112)
C ₁₄ H ₂₀ O ₉	Styracitol tetraacetate.....	EtOH	10.3	22	-20.86	(53)
C ₁₈ H ₂₂ O ₆	1, 1-Diphenylhexane-1, 2, 3, 4, 5, 6-hexol					
	(HO.C(C ₆ H ₅) ₂ .(CHOH) ₅ .H).....	EtOH	0.77		77.9	(1548)
C ₁₈ H ₂₆ O ₁₂	Hexaacetylsorbieritol.....	CHCl ₃	5	18	26.66	(127)
C ₁₈ H ₂₂ O ₆	1, 1-Diphenyl- <i>d</i> -sorbitol.....	H ₂ O	1.23	25	71.25	(1549)
		EtOH	1.47	25	74.75	
C ₁₈ H ₂₂ O ₆	1, 1-Diphenyl- <i>d</i> -galactohexitol					
	(HO.C(C ₆ H ₅) ₂ .(CHOH) ₄ .CH ₂ OH).....	H ₂ O	1.20	20	72.9	(1551)
		EtOH	2.13	20	56.23	
C ₁₈ H ₂₆ O ₁₂	Hexaacetyl- <i>l</i> -iditol.....	CHCl ₃	5	20	25.33	(133)
C ₂₀ H ₂₆ O ₆	1, 1- <i>p</i> -Ditolylsorbitol.....	EtOH	0.4	20	97.1	(1547)

SUGARS CONTAINING 6 CARBON ATOMS

Methylpentoses: Rhamnose and derivatives

C ₆ H ₁₂ O ₅	Rhamnose; cf. (110, 715.5, 993, 1248, 1769, 1912, 1988, 2001, 2180).....	H ₂ O	10	19.5	8.56	(1881)
C ₇ H ₁₅ N ₃ O ₅	Rhamnose semicarbazone (after 120 hr.)....	H ₂ O	40		50*	(1375)
C ₁₀ H ₂₀ O ₅	Trimethylmethylrhamnoside.....		1.0724	20	-62.18	(1746)
		H ₂ O	10.66	20	-15.54	
		EtOH	13.65	20	-53.13	
C ₁₁ H ₂₀ O ₅	Dimethylisopropylidenerhamnoside.....		1.0795	20	-33.40	(1746)
		MeOH	11.02	20	-31.10	
		Me ₂ CO	12.48	20	-35.32	
C ₁₂ H ₁₇ NO ₄	Rhamnoseanilide.....	EtOH		20	77.1	(975)
C ₁₂ H ₁₈ N ₂ O ₄	Rhamnose phenylhydrazone.....	H ₂ O	1.011	20	54.3	(553); cf. (993)

* Mutarotation.

Methylpentoses: Rhamnose and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₃ H ₁₇ NO ₆	Rhamnose- <i>o</i> -carboxyanilide.....	MeOH	very dil.	20	51.2	(968)
C ₁₃ H ₁₈ N ₄ O ₆	Theophyllinerhamnoside.....	H ₂ O	9.105	22	−77.97	(501)
C ₁₉ H ₂₄ N ₄ O ₉	Theophyllinetriacetylramnoside*.....	C ₂ H ₂ Cl ₄	5.85	20	−48.87	(501)
C ₂₀ H ₂₂ O ₅	Dibenzylidenerhamnose.....	MeOH			56.3	(421)
C ₂₁ H ₂₀ O ₁₁	Quercitrin.....	Py	1.112		−140.9	(1453)
<i>Fucose and other methylpentoses</i>						
C ₆ H ₁₂ O ₅	Fucose.....	H ₂ O	6.915	20	−77.0†	(761)
		H ₂ O	7.06		−75.6†	(2036)
C ₆ H ₁₂ O ₅	Rhodoose.....	H ₂ O	4.02		74.5	(2081)
	Isorhodoose.....	H ₂ O	1.44		20.3	(2082)
C ₆ H ₁₂ O ₅	Styracitol.....	H ₂ O		20	−71.72	(52)
C ₆ H ₁₄ O ₅	Fucitol (methylpentitol).....	10% Borax	2.7	20	4.7	(2083)
C ₁₃ H ₂₀ N ₂ O ₄	Fucose methylphenylhydrazone.....	Py	1.85		3.1	(1479)
C ₁₄ H ₂₀ O ₉	Tetraacetylmethylpentose.....	CHCl ₃	3.619		21.64	(1705)
C ₁₉ H ₂₄ N ₂ O ₄	Fucose benzylphenylhydrazone.....	Py	1.85		9.1	(1479)
<i>Ketoses: Fructose and derivatives</i>						
C ₆ H ₁₂ O ₆	<i>d</i> -Fructose (levulose) (H(CHOH) ₄ .CO.CH ₂ OH).....	H ₂ O	6.93	20	−90.9	(941)
		H ₂ O	50	15	96.19	(1598)
C ₇ H ₁₄ O ₆	β-Methyl- <i>d</i> -fructoside.....	H ₂ O	10.02	20	−172.1	(941)
C ₇ H ₁₄ O ₆	Monomethyl- <i>d</i> -fructose.....	H ₂ O	1	20	−53.1†	(967)
		MeOH	1	20	22.1†	
C ₉ H ₁₆ O ₆	α-Isopropylidene- <i>d</i> -fructose; <i>cf.</i> (465.5)....	H ₂ O		20	−159	(963)
C ₁₂ H ₂₀ O ₆	α-Diisopropylidene- <i>d</i> -fructose; <i>cf.</i> (465.5)....	H ₂ O		20	−161	(963)
C ₁₄ H ₁₉ BrO ₉	Tetraacetylbromo- <i>d</i> -fructose.....	CHCl ₃	1.908	20	−186	(232)
		CHCl ₃	3.276	20	−189.1	
C ₁₄ H ₁₉ FO ₉	Tetraacetylfluoro- <i>d</i> -fructose.....	CHCl ₃	5.92	20	−90.43	(232)
C ₁₅ H ₂₂ O ₁₀	Tetraacetyl-β-methyl- <i>d</i> -fructoside.....	CHCl ₃	8	20	−124.6	(941)
C ₁₆ H ₂₂ O ₁₁	Pentaacetyl-α- <i>d</i> -fructose.....	CHCl ₃	8	20	34.75	(940)
		C ₆ H ₆	2.00	20	−105.5	(939, 940)
	Pentaacetyl-β- <i>d</i> -fructose.....	CHCl ₃	5.00	20	−120.9	(939, 940)
<i>Sorbose and other ketoses</i>						
C ₆ H ₁₂ O ₆	<i>d</i> -Sorbose (H(CHOH) ₄ .CO.CH ₂ OH).....	H ₂ O	1		+42.9	(423); <i>cf.</i> (1597.5)
	<i>l</i> -Sorbose.....	H ₂ O	9.957		−43.4	
		H ₂ O	1		−42.9	
<i>Glucose: Alkyl and alkylidene derivatives</i>						
C ₆ H ₁₀ O ₄	Isoglucal (isomer of <div style="text-align: center;"> $\begin{array}{c} \text{O} \\ \diagup \quad \diagdown \\ \text{HO} \cdot \text{CH}_2 \cdot \text{CH}(\text{CHOH})_2 \text{CH} : \text{CH} \end{array}$ </div>).....	H ₂ O	9.37	23	43.15	(111.5)
C ₆ H ₁₀ O ₅	Anhydroglucose.....	H ₂ O	9.35	20	53.9	(559)
C ₆ H ₁₂ O ₅	Glucodesoses, <i>see</i> Methyltetroses, p. 386					
C ₇ H ₁₂ O ₆	Methyleneglucose.....	H ₂ O?	1.13		9.3	(2035)
C ₇ H ₁₄ O ₆	α-6-Monomethylglucose.....	MeOH	1	20	68.5†	(966, 984)
	β-6-Monomethylglucose.....	MeOH	1	20	68.3†	
	Methylglucose.....	H ₂ O	1	20	57†	(1236)
C ₃ H ₁₂ Cl ₂ O ₆	α-Dechlorochloralose.....	H ₂ O		15	9.96	(826)
C ₈ H ₁₆ O ₆	2, 3-Dimethyl-α-glucose.....	AcOH	1.0	20	48.3†	(984)
	2, 3-Dimethyl-β-glucose.....	H ₂ O	5.00	20	64.4†	
		EtOH	5.02	20	49.4†	
		AcOH	3.84	20	50.9†	
C ₉ H ₁₆ O ₆	α-Isopropylideneglucose.....	H ₂ O		20	−11	(963); <i>cf.</i> (465.5)
C ₉ H ₁₈ O ₆	2, 3, 6-Trimethylglucose.....	40% HCl	1.52		92	(912); <i>cf.</i> (839)
		MeOH	0.933		67.5	
	2, 3, 5-Trimethylglucose.....	40% HCl	1.20		91	
	3, 5, 6-Trimethylglucose.....	H ₂ O	4.39	20	−8.32†	(984)
		EtOH	4.67	20	−8.34†	
C ₁₀ H ₁₆ Cl ₆ O ₆	Dichloralglucose (from cellulose).....	CHCl ₃	5		−12	(1800)
C ₁₀ H ₂₀ O ₆	Tetramethyl-γ-glucose.....	H ₂ O	2.080	20	−7.21†	(962)
		MeOH	1.827	20	−19.7	
		C ₆ H ₆	1.641	20	−17.1	

* C₇H₇O₂N₄.C₆H₅O(OCOCH₃)₃. † Mutarotation

Glucose: Alkyl and alkylidene derivatives.—(Continued)

Formula	Name	Solvent	d , C or %	t , °C	$[\alpha]_D$	Lit.
$C_{10}H_{20}O_6$	Tetramethylglucose.....	EtOH	5.01	20	78.2	(1733); cf.
		H ₂ O	5.02	20	80.8	(837, 912)
$C_{10}H_{22}O_6S_2$	Glucoscethylmercaptol (H(CHOH) ₄ .CH- (S.C ₂ H ₅) ₂	H ₂ O	4.878	50	-29.8	(464)
$C_{12}H_{20}O_6$	α -Diisopropylideneglucose.....	H ₂ O		20	-18	(963); cf. (465.5)
$C_{13}H_{22}O_6$	Diisopropylidene-3-methylglucose.....	EtOH			-32.2	(983)
$C_{19}H_{22}N_2O_3$	Isoglucal phenylbenzylhydrazone.....	MeOH	2.45	22	-21.89	(11.5)
<i>Acyl derivatives of glucose</i>						
$C_{12}H_{17}BrO_8$	Triacetylglucose bromohydrin.....	Me ₂ CO	8.738	20	23.33	(559)
$C_{14}H_{19}BrO_9$	Bromotetraacetylglucose.....	CHCl ₃	11.6	19	198.17	(1118)
$C_{14}H_{19}FO_9$	Fluorotetraacetylglucose.....	CHCl ₃	3.05	20	90.08	(231)
$C_{14}H_{19}NO_{12}$	Tetraacetylnitroglucose.....	CHCl ₃	5.21	18	149.30	(1118)
$C_{15}H_{19}NO_{10}$	Tetraacetylcyanoglucose.....	C ₂ H ₂ Cl ₄	5.318	16	15.86	(485)
	Tetraacetylisocyanoglucose.....	C ₂ H ₂ Cl ₄	5.878	19	-7.54	
$C_{16}H_{22}O_{11}$	α -Glucose pentaacetate.....	C ₆ H ₆	7.7	20	96.7	(942)
		CHCl ₃	8.1	20	101.6	
		99.5% Me ₂ CO	8.3	20	108.7	
		50% Me ₂ CO	3.9	20	108.1	
		EtOH (abs.)	0.52	20	100.9	
		MeOH	1.5	20	104.6	
$C_{16}H_{22}O_{11}$	β -Glucose pentaacetate.....	C ₆ H ₆	7.7	20	2.7	(942)
		CHCl ₃	8.3	20	3.8	
		99.5% Me ₂ CO	8.5	20	4.1	
		50% Me ₂ CO	3.6	20	3.2	
		EtOH (abs.)	0.54	20	1.9	
		MeOH	1.2	20	4.9	
$C_{16}H_{22}O_{16}$	β -Pentacarbomethoxyglucose.....	CHCl ₃	5.10	20	1.35	(2241)
$C_{21}H_{24}O_{11}$	β -Tetraacetylbenzoylglucose.....	CHCl ₃	2.10	20	-28.1	(2241)
$C_{21}H_{24}O_{12}$	β -Tetraacetylsalicylglucose.....	CHCl ₃	2.17	20	-43.4	(2241)
$C_{21}H_{32}O_{16}$	β -Pentacarboethoxyglucose.....	CHCl ₃	5.30	20	2.47	(2241)
$C_{23}H_{27}NO_{12}$	β -Tetraacetylhippurylglucose.....	CHCl ₃	2.25	20	3.64	(2241)
$C_{31}H_{52}O_{11}$	β -Pentaisovalerylglucose.....	CHCl ₃	3.56	20	9.1	(2241)
$C_{34}H_{27}BrO_9$	β -Bromotetrabenzoyl- <i>d</i> -glucose.....	PhMe	10.88	20	145.1	(508.5)
$C_{41}H_{32}O_{11}$	Pentabenzoylglucose.....	CHCl ₃	8.387	19	25.37	(508.5)
$C_{41}H_{32}O_{16}$	Penta- <i>p</i> -hydroxybenzoylglucose.....	EtOH	5.157	20	124.3	(503)
		EtOH	4.989	12	128.8	
$C_{41}H_{32}O_{26}$	Pentagalloylglucose.....	H ₂ O	1.0	20	31.4	(503)
		H ₂ O	1.0	20	35.7	
		EtOH	2.250	20	44.4	
$C_{51}H_{42}O_{11}$	α -Pentacinnamylglucose.....	CHCl ₃	2.76	20	198.8	(528)
	β -Pentacinnamylglucose.....	CHCl ₃	4.37	20	-3.6	
$C_{51}H_{42}O_{21}$	Penta-3, 4-dihydroxycinnamylglucose.....	EtOH	1.01	20	57.4	(528)
$C_{51}H_{42}O_{26}$	Penta-(<i>p</i> -carbomethoxyhydroxybenzoyl)- glucose.....	C ₂ H ₂ Cl ₄	2.1	20	100.00	(503)
$C_{58}H_{51}BrO_{33}$	<i>l</i> -Bromotetra-(triacylgalloyl)-glucose.....	Me ₂ CO	1.11	16	58.83	(1039)
$C_{60}H_{54}O_{36}$	Acetyltetra-(triacylgalloyl)-glucose.....	Me ₂ CO	0.555	20	44.9	(1041)
$C_{66}H_{122}O_{11}$	α -Pentalaurylglucose.....	CHCl ₃	2.15	20	40.62	(2241)
	β -Pentalaurylglucose.....	CHCl ₃	6.16	20	3.9	
$C_{71}H_{62}O_{41}$	Penta-(3, 4-dicarbomethoxydihydroxycin- namyl)-glucose.....	CHCl ₃	1.02	20	114.0	(528)
$C_{71}H_{62}O_{56}$	Penta-(tricarbomethoxygalloyl)-glucose.....	C ₂ H ₂ Cl ₄	3.27	20	34.34	(551)
<i>Methylglucosides</i>						
$C_7H_{12}O_6$	Anhydromethylglucoside.....	H ₂ O	8.25	23	-136.6	(559)
$C_7H_{14}O_6$	α -Methylglucoside.....	H ₂ O	1.56	16	157.9	(66); cf. (465.5)
$C_7H_{14}O_6$	β -Methylglucoside.....	H ₂ O	1.689	18	-32.06	(109, 195)
$C_9H_{18}O_6$	2, 3-Dimethyl- α -methylglucoside.....	H ₂ O	5.08	20	142.6	(984)
		EtOH	5.07	20	143.1	
		AcOH	4.25	20	143.5	
$C_{10}H_{18}O_6$	5, 6-Isopropylidenemethylglucoside.....	MeOH	4.45	20	-11.7	(1323)
		EtOH	4.11	20	-11.4	
$C_{10}H_{20}O_6$	Trimethyl- α -methylglucoside.....	MeOH	2.82		160.3	(837)
			1.1656	30	129.8	(1733)

Methylglucosides.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _{<i>D</i>}	Lit.
C ₁₁ H ₂₂ O ₆	Tetramethyl-α-methylglucoside.....		1.1006	20	140.6	(1733)
	Different sample.....		1.1025	20	128.1	
		EtOH	5.01	20	140.5	
	Different sample.....	EtOH	5.42	20	127.8	
		EtOH	12.34	20	31.17	(1734)
		H ₂ O	10.0	20	29.94	
C ₁₁ H ₂₂ O ₆			1.1082	20	171.0	
	Tetramethyl-γ-methylglucoside.....	H ₂ O	2.4995	20	-14.6	(962)
		EtOH	2.4985	20	-3.0	
		Me ₂ CO	2.6215	20	-5.5	
		C ₆ H ₆	2.6665	20	-4.3	
C ₁₂ H ₂₂ O ₆	2, 3-Dimethylmethyl-5, 6-isopropylidene-glucoside.....	MeOH	6.11	20	-19.0	(1323)
		80% EtOH	10.00	20	-15.0	
C ₁₂ H ₂₂ O ₇	2, 3, 6, Trimethyl-5-acetyl-β-methylglucoside	H ₂ O	1.235	26	-14.17	(1875)
C ₁₄ H ₁₈ O ₆	Benzylidene-α-methylglucoside.....	H ₂ O	0.4		85	(421)
	Benzylidene-β-methylglucoside.....	MeOH	1		-75	
C ₁₄ H ₁₉ O ₇	Salicylidene-α-methylglucoside.....	H ₂ O	0.4		91.2	(421)
C ₁₅ H ₂₀ O ₆	<i>p</i> -Toluylidene-α-methylglucoside.....	MeOH			83.2	(421)
C ₁₅ H ₂₂ O ₁₀	Tetraacetyl-α-methylglucoside.....	CHCl ₃	6.3	20	130.55	(942)
		99.5% Me ₂ CO	2.7	20	134.0	
		50% Me ₂ CO	3.0	20	126.5	
		MeOH	2.14	20	135.6	
		EtOH	1.17	20	136.8	
		C ₆ H ₆	4.82	20	175.5	
		C ₆ H ₆	5.39	15	175.58	(1118)
C ₁₅ H ₂₂ O ₁₀	Tetraacetyl-β-methylglucoside.....	CHCl ₃	38.80	20	-18.25	(942)
		99.5% Me ₂ CO	6.5	20	-19.5	
		50% Me ₂ CO	38.80	20	-22.45	
		MeOH	2.29	20	-21.8	
		EtOH	1.48	20	-24.6	
		C ₆ H ₆	4.69	20	-22.8	
		C ₆ H ₆	11.6	15	-23.1	(1118)
C ₁₆ H ₂₂ O ₆	<i>l</i> -5, 6-Benzylidene-2, 3-dimethyl-α-methyl-glucoside.....	AeOH	1.640	20	97.0	(984)
C ₁₇ H ₂₄ O ₇	2, 3, Trimethyl-5-benzoyl-β-methylglucoside	50% EtOH	0.565	18	-23.87	(1875)
C ₁₉ H ₃₀ O ₆	Tetraallyl-α-methylglucoside.....	EtOH		30	116.5	(2038)
C ₃₅ H ₃₀ O ₁₀	Tetrabenzoyl-β-methyl-α-glucoside.....	CHCl ₃	7.185	19	30.99	(508.5)
C ₃₅ H ₂₀ O ₂₂	Tetragalloyl-α-methylglucoside.....	H ₂ O	4.08	20	26.39	(503)
C ₅₉ H ₅₄ O ₃₄	Tetra-(triacetylgalloyl)-β-methylglucoside...	Me ₂ CO	1.01	19	32.9	(1039)
	Tetra-(triaethylgalloyl)-α-methylglucoside...	Me ₂ CO	1.294	18.5	42.36	
<i>Other aliphatic glucosides (including glucosides of geraniol and cholesterol)</i>						
C ₈ H ₁₆ O ₆	α-Ethylglucoside.....	H ₂ O	0.98	21	150.9	(66); <i>cf.</i> (465.5)
	β-Ethylglucoside.....	H ₂ O	3.98	20	-30.11	(1118); <i>cf.</i> (195.5)
		H ₂ O	2		-33.38	(190, 195.5)
C ₁₆ H ₂₄ O ₁₀	Tetraacetyl-β-ethylglucoside.....	C ₆ H ₆	10.2	16.5	-27.01	(1118)
C ₈ H ₁₆ O ₇	Glycol-α-monoglucoside (C ₆ H ₁₁ O ₅ .OCH ₂ .CH ₂ OH).....	H ₂ O	3.00	18	135.5	(205)
	Glycol-β-monoglucoside.....	H ₂ O	4.42	18	-30.5	
C ₈ H ₁₄ O ₈	β- <i>d</i> -Glucosidoglycolic acid (C ₆ H ₁₁ O ₅ .OCH ₂ .COOH).....	H ₂ O	8.984	21	-44.11	(508.5)
		H ₂ O	9.054	21	-43.79	
C ₈ H ₁₅ NO ₇	β- <i>d</i> -Glucosidoglycolic amide (C ₆ H ₁₁ O ₅ .OCH ₂ .CONH ₂).....	H ₂ O	10.007	18	-42.8	(508.5)
		H ₂ O	9.888	18	-43.24	
C ₁₈ H ₂₆ O ₁₂	Ethyl tetraacetyl-β- <i>d</i> -glucosidoglycolate (C ₆ H ₇ O(O.COCH ₃) ₄ .OCH ₂ .CO.OC ₂ H ₅).....	EtOH	2.351	35	-39.94	(508.5)
C ₉ H ₁₆ O ₆	Allyl-α-glucoside.....	H ₂ O	1.18		131.7	(217, 219)
	Allyl-β-glucoside.....	H ₂ O	2.4786		-40.34	(191)
C ₉ H ₁₈ O ₆	<i>n</i> -Propyl-α-glucoside.....	H ₂ O	1.14		140.8	(219)
		H ₂ O	1.136		140.8	(217, 219)
	<i>n</i> -Propyl-β-glucoside.....	H ₂ O	2.0680		-38.68	(195)

Other aliphatic glucosides (including glucosides of geraniol and cholesterol).—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₉ H ₁₈ O ₆	Isopropyl-β-glucoside.....	H ₂ O	2.0666		−36.3	(195)
C ₁₀ H ₂₀ O ₆	Butyl-β-glucoside.....	H ₂ O	2.117		−35.4	(191, 196)
	Isobutyl-β-glucoside.....	H ₂ O	2.6693		−34.96	
		H ₂ O	2.17		−39.18	(197.5)
C ₁₁ H ₂₂ O ₆	Amyl-β-glucoside.....	H ₂ O	7.41	20	−17.2	(539)
C ₁₁ H ₂₂ O ₆	Isoamyl-β-glucoside.....	H ₂ O	2.1973		−36.40	(193, 197, 539)
C ₁₆ H ₂₈ O ₆	Geranyl-β- <i>d</i> -glucoside (C ₆ H ₁₁ O ₆ .OCH ₂ -CH: C(CH ₃) ₃ . (CH ₂) ₂ .CH: C(CH ₃) ₂).....	H ₂ O	7.603	27	−37.25	(508.5)
		H ₂ O	1.6		−25.49	(200, 201, 204)
C ₂₂ H ₄₄ O ₆	β-Cetyl- <i>d</i> -glucoside.....	EtOH	3.805	24	−22.02	(508.5)
C ₂₄ H ₃₆ O ₁₀	Tetraacetylgeranyl-β- <i>d</i> -glucoside.....	EtOH	2.378	22	−25.17	(508.5)
C ₃₀ H ₆₂ O ₁₀	Tetraacetyl-β-cetyl- <i>d</i> -glucoside.....	EtOH	1.852	20	−19.69	(508.5)
C ₄₁ H ₈₄ O ₁₀	Tetraacetylcholesteryl- <i>d</i> -glucoside.....	CHCl ₃	0.911		−23.8	(1857)
	Tetraacetyl sitosteryl- <i>d</i> -glucoside.....	CHCl ₃	2.847		−22.9	(1857)
C ₆₁ H ₇₂ O ₁₀	Tetrabenzoylsitosteryl- <i>d</i> -glucoside.....	CHCl ₃	2.366		18.3	(1857)
<i>Aromatic and hydroaromatic glucosides (with some glucosides of unknown structure)</i>						
C ₁₂ H ₁₃ Br ₃ O ₆	Tribromo-2, 4, 6-phenyl- <i>d</i> -glucoside.....	Py	8.395	26	−23.29	(550)
C ₁₂ H ₁₆ O ₆ S	Phenylthiolglucoside (C ₆ H ₁₁ O ₅ .S.C ₆ H ₅).....	H ₂ O	9.95	20	−72.5	(498)
C ₁₂ H ₁₆ O ₆	Phenyl-α-glucoside.....	H ₂ O	1.91	20	180.8	(525)
	Phenyl-β-glucoside.....	H ₂ O	2.68	20	−71.9	(525)
		H ₂ O	3.91	20	−71.0	(488)
		H ₂ O	3		−63.84	(211); cf. (851)
C ₁₂ H ₁₆ O ₇	Arbutin (quinol- <i>d</i> -glucoside, C ₆ H ₁₁ O ₆ .O.C ₆ H ₄ OH).....	H ₂ O			−64.7	(215)
C ₁₂ H ₁₆ O ₇	Resorcinol- <i>d</i> -glucoside.....	H ₂ O	7.952	23	−70.41	(550)
C ₁₂ H ₁₆ O ₈	Phloroglucinol- <i>d</i> -glucoside.....	Py	7.008	20	−74.79	(550)
		Py	8.780	22	−74.58	
		H ₂ O	3.10	20	−24.20	(2077)
		EtOH	5.25	20	−24.95	
C ₁₂ H ₂₂ O ₆	β-Cyclohexanol- <i>d</i> -glucoside.....	H ₂ O	9.800	20	−41.43	(508.5)
C ₁₃ H ₁₆ O ₇	Glucosido- <i>p</i> -hydroxybenzaldehyde.....	H ₂ O	2.18	21	−94.45	(1404.5)
C ₁₃ H ₁₆ O ₈	Glucosido- <i>m</i> -hydroxybenzoic acid.....	EtOH			−68.41	(1404.8)
C ₁₃ H ₁₆ O ₁₀	β-Glucosidogallie acid.....	H ₂ O	9.670	20	−21.3	(551)
C ₁₃ H ₁₇ NO ₈	<i>m</i> -Nitrobenzyl-β-glucoside.....	H ₂ O	1.43	18	−52.59	(221)
C ₁₃ H ₁₈ O ₆	β-Benzyl- <i>d</i> -glucoside (C ₆ H ₁₁ O ₆ .OCH ₂ .C ₆ H ₅).....	H ₂ O	1.255		−49.78	(192); cf. (508.5)
C ₁₃ H ₁₈ O ₇	Arbutin methyl ether.....	H ₂ O			−63.43	(215)
C ₁₃ H ₁₈ O ₇	Salicin (salicyl-β-glucoside, C ₆ H ₁₁ O ₆ .O.C ₆ H ₄ .CH ₂ .OH).....	H ₂ O	1.6		−37.5	(216)
		H ₂ O	0.972		−65.15	(194)
		40% EtOH	1.004		−53.14	
		85% EtOH	0.976		−49.82	
C ₁₃ H ₂₁ O ₉	Aucubin.....	H ₂ O	4.24		−174.4	(213)
C ₁₃ H ₂₁ O ₉ .H ₂ O	Hydrated.....	H ₂ O	4.24		−164.9	(213)
C ₁₃ H ₂₂ O ₇	Taxicatin.....	95% EtOH	1.71		−67.25	(1185)
		H ₂ O	1		−71.65	
C ₁₄ H ₁₇ NO ₆	Sambunigrin (C ₆ H ₁₁ O ₆ .O.CH(CN).C ₆ H ₅)....	H ₂ O?	1.16		−76.3	(210)
C ₁₄ H ₁₈ O ₇ .H ₂ O	Glucosido- <i>p</i> -hydroxyacetophenone (C ₆ H ₁₁ O ₆ .O.C ₆ H ₄ .CO.CH ₃).....	H ₂ O			−88.87	(1404.8)
C ₁₄ H ₂₀ O ₆	Phenethyl- <i>d</i> -β-glucoside (C ₆ H ₁₁ .OCH ₂ .CH ₂ .C ₆ H ₅).....	H ₂ O	2.02		−23.92	(201)
	<i>m</i> -Hydroxymethylbenzylmono-β-glucoside...	H ₂ O	1.747		−46.86	(222, 223)
C ₁₄ H ₂₀ O ₇	<i>p</i> -Hydroxymethylbenzylmono-β-glucoside (C ₆ H ₁₁ O ₅ .OCH ₂ .C ₆ H ₄ .CH ₂ OH).....	H ₂ O	2.317		−50.47	
C ₁₄ H ₂₀ O ₇	<i>o</i> -Methoxybenzyl-β-glucoside.....	H ₂ O	1.18	18	−52.24	
	<i>p</i> -Methoxybenzyl-β-glucoside..... (C ₆ H ₁₁ O ₅ .OCH ₂ .C ₆ H ₄ .OCH ₃)	H ₂ O	1.0	18	−53.33	(221)
C ₁₅ H ₂₀ O ₆	Cinnamyl- <i>d</i> -β-glucoside (C ₆ H ₁₁ O ₅ .OCH ₂ .CH: C ₆ H ₅).....	H ₂ O	2.142		−46.46	(201)
C ₁₆ H ₂₈ O ₆	Anhydromenthylglucoside.....	EtOH	11.25	25	−96.50	(559)
C ₁₆ H ₂₈ O ₆	<i>d</i> -Bornylglucoside (C ₆ H ₁₁ O ₆ .O.C ₁₀ H ₁₇).....	EtOH	8.1	20	−42.1	(539)
C ₁₆ H ₃₀ O ₆	Menthylglucoside (C ₆ H ₁₁ O ₆ .O.C ₁₀ H ₁₉).....	EtOH	8.18	20	−93.0	(539)
C ₁₈ H ₂₈ O ₇	Pentamethylsalicin.....	MeOH	4.7	20	−52.15	(982)

Aromatic and hydroaromatic glucosides (with some glucosides of unknown structure).—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>c</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₉ H ₂₀ O ₇	Glucosido- <i>p</i> -hydroxybenzophenone (C ₆ H ₁₁ O ₅ .O.C ₆ H ₄ .CO.C ₆ H ₅)	EtOH			−55.58	(1404.8)
C ₁₉ H ₂₂ O ₇	Arbutin benzyl ether.	EtOH		17	−44.47	(215)
C ₁₉ H ₂₃ BrO ₈	Triacetylbenzylglucosidebromohydrin.	CHCl ₃	6.998	20	−46.76	(559)
C ₂₀ H ₂₁ Br ₃ O ₁₀	Tribromo-2, 4, 6-phenol-tetraacetyl- <i>d</i> - glucoside.	Py	9.497	25	−8.89	(550)
C ₂₀ H ₂₄ O ₉ S	Tetraacetylphenylthiolglucoside.	PhMe	5.05	20	−40.1	(498)
C ₂₀ H ₂₄ O ₁₀	Tetraacetylphenol- α -glucoside.	C ₆ H ₆	8.75	20	165.4	(525); cf. (488)
	Tetraacetylphenol- β -glucoside.	C ₆ H ₆	1.09	20	−28.9	
C ₂₀ H ₃₀ O ₁₀	Tetraacetyl- β -cyclohexanol- <i>d</i> -glucoside.	EtOH	2.076	22	−29.74	(508.5)
C ₂₁ H ₂₄ O ₇	<i>p</i> -Toluylidenesalicin.	MeOH	0.4		−16	(421)
C ₂₁ H ₂₄ O ₁₁	Tetraacetylhelicin.	C ₆ H ₆	5.69	20	−23.48	(548)
		Me ₂ CO	10.9	20	−37.15	
C ₂₁ H ₂₆ O ₁₀	Tetraacetyl- β -benzyl- <i>d</i> -glucoside.	EtOH	2.072	22	−49.51	(508.5)
C ₂₂ H ₂₆ NO ₁₁	Tetraacetylhelicinycyanohydrin.	Me ₂ CO	10.9	20	−24.32	(548)
C ₂₂ H ₃₆ BrO ₈	Triacetylmenthyl- <i>d</i> -glucosidebromohydrin.	CHCl ₃	9.396	20	−49.75	(559)
C ₂₃ H ₂₈ O ₁₄	Ethyl tetraacetylglucosidogallate.	C ₂ H ₂ Cl ₄	6.207	20	−10.66	(551)
		C ₂ H ₂ Cl ₄	6.294	20	−10.63	
C ₂₄ H ₃₄ O ₅	Sapogenine.	EtOH	0.9190	18	90.86	(1798)
<i>Heterocyclic glucosides</i>						
C ₁₁ H ₁₃ Cl ₂ N ₅ O ₆	2, 8-Dichloroadenine- <i>d</i> -glucoside.	H ₂ O	0.434	20	9.2	(509)
C ₁₁ H ₁₄ ClN ₅ O ₆	Chloroadenine- <i>d</i> -glucoside.	H ₂ O	0.914	20	−7.66	(509)
C ₁₁ H ₁₄ N ₄ O ₆	Hypoxanthine- <i>d</i> -glucoside.	N NaOH	6.8	20	−34.50	(509)
		N HCl	6.9	20	12.92	
		H ₂ O	5	20	0	
C ₁₁ H ₁₆ N ₅ O ₆	Adenine- <i>d</i> -glucoside (6-Aminopurine- <i>d</i> -glucoside).	H ₂ O	3.215	19	−10.50	(509)
		N HCl	6.12	20	5.51	
C ₁₁ H ₁₆ N ₆ O ₆	Guanine- <i>d</i> -glucoside.	N NaOH	7.4	15	−41.94	(509)
		N NaOH	7.7	15	−41.34	
C ₁₃ H ₁₇ ClN ₄ O ₇	Chlorotheophylline- <i>d</i> -glucoside.	H ₂ O	6.3	20	18.88	(509)
C ₁₃ H ₁₈ N ₄ O ₇	Theobromine- <i>d</i> -glucoside.	H ₂ O	3.881	20	−49.58	(509)
	Theophylline- <i>d</i> -glucoside.	N HCl	8.8	20	1.08	
		H ₂ O	9.18	20	−2.33	
C ₁₉ H ₁₉ Cl ₃ N ₄ O ₉	Tetraacetyltrichloropurine- <i>d</i> -glucoside.	C ₂ H ₂ Cl ₄	6.2	19	−26.48	(509)
C ₁₉ H ₂₁ Cl ₂ N ₆ O ₉	Tetraacetyl-2, 8-dichloro-6-aminopurine- <i>d</i> - β -glucoside.	C ₂ H ₂ Cl ₄	2.5	17	−16.52	(509)
C ₂₁ H ₂₆ ClN ₄ O ₁₁	Tetraacetylchlorotheophylline- <i>d</i> - β -glucoside.	PhMe	7.360	21	−15.95	(509)
C ₂₁ H ₂₆ N ₄ O ₁₁	Tetraacetyltheobromine- <i>d</i> - β -glucoside.	C ₂ H ₂ Cl ₄	5.9	20	−18.42	(509)
C ₂₁ H ₂₆ N ₄ O ₁₁	Tetraacetyltheophylline- <i>d</i> -glucoside.	C ₂ H ₂ Cl ₄	5.9	20	−12.36	(509)
C ₂₂ H ₂₈ N ₄ O ₁₂	Tetraacetylhydroxycaffeine- <i>d</i> - β -glucoside.	C ₂ H ₂ Cl ₄	4.0	25	1.81	(509)
C ₂₅ H ₃₆ ClN ₂ O ₇	Dihydrocupreincglucoside hydrochloride.	H ₂ O	2.69	20	−160	(1037)
C ₃₂ H ₄₀ N ₂ O ₁₉ S	2-Thiouracildi-[tetraacetylglucoside].	C ₂ H ₂ Cl ₄	7.20	19.5	12.59	(485)
C ₃₃ H ₄₃ ClN ₂ O ₁₁	Dihydrocupreinetetraacetyl- <i>d</i> -glucoside hydrochloride.	H ₂ O	4.43	18	−1.88	(1037)
<i>Nitrogen derivatives of glucose: Oxime, osazone, etc.</i>						
C ₆ H ₁₃ NO ₆	Glucosoxime.	H ₂ O	10	20	−2.2*	(107); cf. (992)
C ₇ H ₁₄ N ₂ O ₅ S	Glucose thiocarbamide.	H ₂ O	9.010	20	−35.73	(485)
C ₇ H ₁₄ N ₂ O ₆	Glucose carbamide.	H ₂ O	7.861	19	−23.41	(485)
C ₇ H ₁₅ N ₃ O ₆	Glucose semicarbazone.	H ₂ O	2.5		−9*	(1375)
C ₁₂ H ₁₈ N ₂ O ₆	Glucose α -phenylhydrazone.	H ₂ O	4.0	19	−80.7	(1992); cf. (108, 993)
	Glucose β -phenylhydrazone.	H ₂ O	5		−50*	(107); cf. (108)
C ₁₈ H ₂₂ N ₄ O ₄	Glucosazone (initial).	Py	0.8		−104	(1992)
<i>Nitrogen derivatives of glucose: Glucosamine, epiglucosamine and derivatives</i>						
C ₆ H ₁₃ NO ₆	Glucosamine.	H ₂ O	4.605		22.6*	(987)
		MeOH aq	1.932		21.2*	
C ₆ H ₁₂ ClNO ₄	Anhydroepiglucosamine hydrochloride.	2.5% HCl	1	20	−172	(1235)
C ₆ H ₁₄ BrNO ₅	Glucosamine hydrobromide.	H ₂ O	5.312	20	60.23	(2023)
C ₆ H ₁₄ ClNO ₅	Glucosamine hydrochloride.	H ₂ O	5.158	20	74.64	(2157)
		H ₂ O	2.593	20	70.61	
		H ₂ O	22.555	20	59.37	

* Mutarotation.

Nitrogen derivatives of glucose: Glucosamine, epiglucosamine and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₇ H ₁₆ NO ₅	α-Aminomethylglucoside.	MeOH	2.703	20	−16.65	(969)
		MeOH	2.572	20	−14.8	
C ₇ H ₁₆ BrNO ₅	Hydrobromide.	H ₂ O	2.432	20	−20.2	(969)
C ₇ H ₁₆ ClNO ₅	Hydrochloride.	H ₂ O	8.985	20	−24.2	(969, 971)
C ₇ H ₁₆ BrNO ₅	β-Aminomethylglucoside hydrobromide.	H ₂ O	9.005	20	−21.2	(558)
C ₇ H ₁₆ ClNO ₅	β-Aminomethylglucoside hydrochloride.	H ₂ O	9.661	20	−25.1	(558)
C ₇ H ₁₆ ClNO ₅	Methylepiglucosamine hydrochloride.	2.5% HCl	1	20	−138	(1235)
C ₈ H ₁₇ NO ₅	Ethylaminoglucose.	EtOH	0.770		−12.3*	(987)
C ₈ H ₁₇ NO ₅	α-Monomethylaminomethylglucoside.	MeOH	2.0	20	−14.95	(969)
		H ₂ O	2.0	20	−12.99	
C ₈ H ₁₈ ClNO ₅	Aminoethylglucoside hydrochloride.	H ₂ O	2.685	20	−27.7	(971)
C ₉ H ₁₇ NO ₇	Ethyl glucosaminocarboxylate.	H ₂ O	14.85	10.25	33.18	(572)
C ₉ H ₁₉ NO ₇	Methylepiglucosamine acetate.	2.5% HCl	1	20	−130	(1235)
C ₁₀ H ₁₈ N ₂ O ₇	Succinamide- <i>d</i> -glucoside (C ₆ H ₁₁ O ₅ .NH.CO.CH ₂ .CH ₂ .CO.NH ₂).	H ₂ O	8.453	18	−17.35	(485)
		H ₂ O	7.720	19	−17.40	
C ₁₂ H ₁₉ Br ₂ NO ₇	Bromotriacetylglucosamine hydrobromide.	Me ₂ CO	5.01		148.4*	(976)
		AcOEt	1.096		152.8	
C ₁₃ H ₁₈ ClNO ₆	α-Aminohelicin hydrochloride.	H ₂ O		20	−9.0	(971)
C ₁₃ H ₂₀ ClNO ₆	Aminobenzylglucoside hydrochloride.	H ₂ O	1.0	20	−51.2	(971)
C ₁₃ H ₂₀ ClNO ₆	α-Aminosalicin hydrochloride.	H ₂ O	3.606	20	−19.0	(971)
C ₁₃ H ₂₂ BrNO ₈	Triacetylmethylglucosamine hydrobromide.	MeOH	2.098		20.26	(976)
		H ₂ O	1.24		20.56	
C ₁₃ H ₂₂ BrNO ₈	Triacetyl-α-aminomethylglucoside hydro- bromide.	MeOH		20	20.3	(971)
C ₁₄ H ₂₄ BrNO ₈	Triacetyl-α-aminoethylglucoside hydro- bromide.	MeOH	1.806	20	12.5	(971)
C ₁₆ H ₂₆ NO ₁₁	Glucosamine α-pentaacetate.	CHCl ₃	2.55	20	93.5	(944)
	Glucosamine β-pentaacetate.	CHCl ₃	4.4	20	1.3	
C ₁₇ H ₂₆ NO ₆ .H ₂ O	Tetramethylglucose- <i>p</i> -toluidide.	MeOH	1.09	20	53.5*	(968)
C ₁₇ H ₂₆ NO ₁₀ S	Tetracetylglucosothiourethane (C ₆ H ₇ O(OCOCH ₃) ₄ .NH.CS.OC ₂ H ₅).	C ₂ H ₂ Cl ₄	5.88	21	11.53	(485)
C ₁₇ H ₃₀ BrNO ₈	Triacetyl-α-aminoamylglucoside hydro- bromide.	MeOH	1.687	20	10.4	(971)
C ₁₈ H ₂₃ NO ₁₁	Tetraacetylsuccinimide- <i>d</i> -glucoside (C ₆ H ₇ O(OCOCH ₃) ₄ .NC ₄ H ₄ O ₂).	C ₂ H ₂ Cl ₄	6.170	18	12.81	(485)
		C ₂ H ₂ Cl ₄	5.351	18	12.73	
C ₁₉ H ₂₄ BrNO ₉	Triacetyl-α-aminohelicin hydrobromide.	MeOH		20	43.6*	(971)
C ₁₉ H ₂₆ BrNO ₈	Triacetyl-α-aminobenzylglucoside hydrobromide.	MeOH	1.372	20	52.1	(971)
C ₂₃ H ₃₀ N ₂ O ₇	α-Aminomorphineglucoside.	H ₂ O	1.0	20	−113.5	(971)
C ₄₁ H ₃₃ NO ₁₀	Pentabenzoylglucosamine.	Py	2.61	20	44.4	
<i>Nitrogen derivatives of glucose: Glucosanilide, etc.</i>						
C ₉ H ₁₇ NO ₇	Glucosanil.	H ₂ O	1.00	20	45.7	(968)
C ₁₂ H ₁₇ NO ₆	Glucosanilide.	MeOH	5.029	21.0	−48.32	(1976); cf.
		MeOH	3.326	21.0	−49.15	(964)
		90% EtOH	4.697	21.0	−44.08	
		90% EtOH	3.269	21.0	−44.15	
C ₁₃ H ₁₇ NO ₇ .H ₂ O	Glucose- <i>o</i> -carboxyanilide.	MeOH	2.5	20	−14.5*	(965)
C ₁₃ H ₁₉ NO ₅	Glucose- <i>p</i> -toluidide.	MeOH	2.0	20	181.9	(965)
		MeOH	7.879	23.0	−43.88	(1976)
		MeOH	2.613	23.0	−38.23	
		90% EtOH	6.658	23.0	−38.80	
C ₁₃ H ₁₉ NO ₆	ζ-Monomethylglucoseanilide.	MeOH	0.636	20	−49.0*	(966)
C ₁₄ H ₂₁ NO ₆ .H ₂ O	Glucose- <i>p</i> -phenetide.	MeOH	3.47	20	−38.3	(965)
C ₁₆ H ₁₉ NO ₆ .H ₂ O	Glucose-β-naphthylamide.	MeOH	2.5	20	−48.1*	(965)
C ₁₆ H ₂₆ NO ₅	Tetramethylglucosanilide.	MeOH		20	47.0*	(964)
<i>Mannose and derivatives</i>						
C ₁₀ H ₂₀ O ₆	Tetramethylmannose.	H ₂ O	5	20	1.2*	(977)
		MeOH	5	20	17.2*	
C ₁₁ H ₂₂ O ₆	Tetramethyl α-methylmannoside.	H ₂ O	9.99	20	42.9	(977); cf. (837)
		MeOH	10.0	20	70.5	
		EtOH	7.95	20	75.5	
C ₁₂ H ₂₀ O ₆	Diisopropylidenemannose.	C ₂ H ₂ Cl ₄	9.03	19	14.3*	(669)
C ₁₃ H ₂₂ O ₆	Diisopropylidenemethylmannose.	C ₂ H ₂ Cl ₄	9.17	19	−41.0*	(669)

* Mutarotation.

Mannose and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₆ H ₂₀ O ₆	<i>p</i> -Toluylidene α-methylmannoside.....	MeOH			29.5	(421)
C ₁₆ H ₂₂ O ₁₀	α-Tetraacetylmethyl- <i>d</i> -mannoside.....	CHCl ₃	4.43	20	49.1	(366)
	β-Tetraacetylmethyl- <i>d</i> -mannoside.....	CHCl ₃	1.28	20	-47.0	
	γ-Tetraacetylmethyl- <i>d</i> -mannoside.....	CHCl ₃	4.15	20	-26.6	
C ₁₆ H ₂₂ O ₁₁	α-Pentaacetylmannose.....	CHCl ₃	4.7	20	55.0	(943)
		H ₂ O	2.5	17	57.6	(1228)
	β-Pentaacetylmannose.....	CHCl ₃	8.3	20	-25.2	
		CHCl ₃	8.06	20	-24.9	
C ₂₁ H ₂₂ O ₆	Dibenzylidene-α-methylmannoside.....	CHCl ₃	0.4		-5	(421)
C ₄₁ H ₃₂ O ₁₁	Pentabenzoylmannose.....	CHCl ₃	8.92	20	-80.44	(528)
C ₅₁ H ₄₂ O ₁₁	Pentacinnamylmannose.....	C ₆ H ₆	9.98	20	-99.9	(528)
<i>Nitrogen derivatives of mannose</i>						
C ₆ H ₁₃ NO ₆	Mannose oxime (H(CHOH) ₅ CH:NOH).....	H ₂ O	4.798	20	3.2*	(992)
C ₆ H ₁₆ NO ₅	Mannamine (H(CHOH) ₅ CH ₂ NH ₂).....	H ₂ O	10		-2	(1804.5)
C ₇ H ₁₅ N ₃ O ₆	Mannose semicarbazone.....	H ₂ O	40		-43*	(1375)
C ₁₂ H ₁₇ NO ₅	Mannosecanilide.....	Py	2.0	20	-81.5*	(975)
C ₁₃ H ₁₇ NO ₇	Mannose- <i>o</i> -carboxyanilide.....	MeOH	2.04	20	-21.1*	(968)
C ₁₄ H ₃₂ N ₂ O ₁₄	Dimannamine oxalate.....	H ₂ O	10		4.25	(1804.5)
C ₁₆ H ₂₅ NO ₅	Tetramethylmannosecanilide.....	MeOH	2.10	20	-8.3*	(975)
<i>Galactose and alkyl, alkylidene and acyl derivatives</i>						
C ₆ H ₁₂ O ₆	Galactose.....	H ₂ O	50	14.6	84.23	(1598)
		H ₂ O	9.09	20	80.8	(845)
		Py	0.62		55.6†	
C ₈ H ₁₆ O ₆	Galactite (α-ethylgalactoside).....	H ₂ O	10.42	19	186.2	(484)
C ₁₀ H ₂₀ O ₆	Tetramethylgalactose.....	H ₂ O	1.766		84.9	(1722)
		H ₂ O	10	20	109.5	(961)
		EtOH	10	20	62.6	
		C ₆ H ₆	10	20	90.0	
C ₁₁ H ₂₂ O ₆	Pentamethylgalactose.....	EtOH	7.65	20	21.5	(961)
C ₁₂ H ₂₀ O ₆	Diisopropylidenegalactose.....	C ₂ H ₂ Cl ₄	9.21		-60.9†	(669)
C ₁₃ H ₂₂ O ₆	Diisopropylidenemethylgalactose.....	C ₂ H ₂ Cl ₄	1.07	19	63.2†	(669)
C ₁₄ H ₁₉ BrO ₉	β-Tetraacetylbromogalactose.....	C ₆ H ₆	9.89	20	236.4	(489)
C ₁₄ H ₁₉ ClO ₉	Tetraacetylchlorogalactose.....	CHCl ₃	6.2	20	-79.1	(947)
C ₁₄ H ₁₉ NO ₁₂	Tetraacetylnitrogalactose.....	CHCl ₃	5.26	20	153.2	(1118)
C ₁₄ H ₂₀ O ₁₀	Tetraacetylgalactose.....	CHCl ₃	3.96	25	137.17	(1962)
C ₁₄ H ₂₀ O ₁₀	Galactose tetraacetate.....	CHCl ₃	4.7	20	-17.8	(947)
		C ₆ H ₆	3.5	20	-23.4	
		AcOH	4.1	20	-11.0	
		H ₂ O	4.4	20	-12.9	
C ₁₆ H ₂₂ O ₁₁	Galactose pentaacetate (M. P. 142).....	CHCl ₃		20	25	(937)
	(M. P. 95-96°).....	CHCl ₃		20	107	
	(M. P. 98°).....	CHCl ₃		20	-41.6	
	Galactose pentaacetate (1st isomeride).....	CHCl ₃			23	(947); cf. (695, 845)
	(2nd isomeride).....	CHCl ₃			107	
	(3rd isomeride).....	CHCl ₃			-42	
	(4th isomeride).....	CHCl ₃	4.28		61	
		C ₆ H ₆	3.52		44.8	
		AcOH	3.04		62.4	
		Ac ₂ O	3.08		70.2	
C ₁₉ H ₂₆ O ₈ S	Diisopropylidenegalactose toluene- <i>p</i> -sulfonate.....	C ₂ H ₂ Cl ₄	9.16		-64.7*	(669)
<i>Galactosides</i>						
C ₇ H ₁₄ O ₆	α-Methyl- <i>d</i> -galactoside.....	H ₂ O	0.983		192.7	(181.5); cf. (465.5)
	β-Methyl- <i>d</i> -galactoside.....	H ₂ O	4.05		-0.42	
	β-Methylgalactoside.....	H ₂ O	4.05		0	(199); cf. (181, 202)
C ₈ H ₁₆ O ₆	α-Ethyl- <i>d</i> -galactoside.....	H ₂ O	1.20		185.4	(181.5)
	β-Ethyl- <i>d</i> -galactoside.....	H ₂ O	4.57		-4.00	(490)
		H ₂ O	49.0	20	-7.21	(224)
		H ₂ O	0.85		185.5	(852); cf. (465.5, 484)

* [α]_D²⁰. † Mutarotation.

Galactosides.—(Continued)

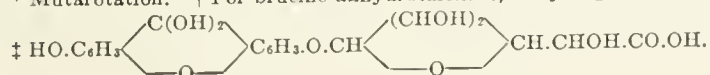
Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₈ H ₁₆ O ₆	β -Ethylgalactoside.....	H ₂ O	2		−4.0	(193, 197); cf. (224)
C ₈ H ₁₆ O ₇	Ethyleneglycol- α -monogalactoside.....	H ₂ O		20	169.9	(27, 209)
	Ethyleneglycol- β -monogalactoside.....	H ₂ O			0	(206.5, 208)
C ₈ H ₁₆ O ₇	Ethyleneglycolmono- <i>d</i> - β -galactoside.....	H ₂ O	2.63	20	0	(181.5)
	Ethyleneglycolmono- <i>d</i> - α -galactoside.....	H ₂ O	1.78	20	169.9	
C ₈ H ₁₆ O ₇	Glycol- α , β -monogalactoside (C ₆ H ₁₁ O ₆ .CH ₂ .CH ₂ OH).....	H ₂ O	2.6	17.5	0	(208)
	Glycol- <i>d</i> - α -monogalactoside.....	H ₂ O	1.78	18	169.9	(209)
C ₉ H ₁₆ O ₆	β -Allyl- <i>d</i> -galactoside.....	H ₂ O	2.74		−12.15	(181.5); cf. (196)
C ₉ H ₁₈ O ₆	β -Propylgalactoside.....	H ₂ O	2.26		−8.86	(218); cf. (181.5)
C ₉ H ₁₈ O ₆	α -Propyl- <i>d</i> -galactoside.....	H ₂ O	1.87	20	179.0	(181.5); cf. (185)
C ₁₀ H ₂₀ O ₆	β -Isobutyl- <i>d</i> -galactoside.....	H ₂ O	2.9		−11.23	(181.5); cf. (203)
C ₁₁ H ₂₂ O ₆	2, 3, 5, 6-Tetramethyl- β -methylgalactoside..	H ₂ O	0.9872	20	19.59	(1875)
C ₁₁ H ₂₂ O ₆	Tetramethyl- α -methylgalactoside.....	EtOH	10.25	20	109.9	(961)
		H ₂ O	10.02	20	143.4	
	Tetramethyl- β -methylgalactoside.....	H ₂ O	1.311		4.4	(1722)
C ₁₂ H ₁₆ O ₆	β -Phenol- <i>d</i> -galactoside.....	H ₂ O	4.45	20	−39.38	(489)
C ₁₃ H ₁₈ O ₆	β -Benzyl- <i>d</i> -galactoside.....	H ₂ O	2.99		−25.05	(181.5); cf. (218)
C ₁₄ H ₁₈ O ₆	Benzylidene- α -methylgalactoside.....	MeOH	1		120.7	(421)
C ₁₅ H ₂₀ O ₆	<i>p</i> -Toluidene- α -methylgalactoside.....	MeOH	0.4		14.2	(421)
C ₁₅ H ₂₂ O ₁₀	Tetraacetyl- β -methylgalactoside.....	C ₆ H ₆	10.0	17	−25.47	(1118)
C ₁₆ H ₂₄ O ₁₀	Tetraacetyl- β -ethylgalactoside.....	C ₆ H ₆	10	20	−29.8	(490)
C ₂₀ H ₂₄ O ₁₀	Tetraacetyl- β -phenolgalactoside.....	C ₆ H ₆	7.47	20	−25.77	(489)
Nitrogen derivatives of galactose						
C ₆ H ₁₃ NO ₅	Galactamine (H(CHOH) ₅ .CH.NH ₂).....	H ₂ O	10		−2.77	(1802)
C ₆ H ₁₃ NO ₆	Galactose oxime (H(CHOH) ₅ .CH:NOH)....	H ₂ O	5.106	20	14.75*	(992)
C ₇ H ₁₅ N ₃ O ₆	Galactose semicarbazone (after 48 hr.).....	H ₂ O	40		16†	(1375)
C ₁₂ H ₁₇ NO ₅	Galactoseanilide.....	90% EtOH	2.289	20	−31.33	(1976)
		MeOH	1.699	21	−33.12	
		EtOH	0.6167	21	−33.99	
		90% EtOH	2.3	20	−6.93†	(975)
		MeOH	0.507	20	−31.6†	
C ₁₂ H ₁₈ N ₂ O ₆	Galactose phenylhydrazine.....	H ₂ O	1.98	20	−20.6	(993); cf. (553)
C ₁₃ H ₁₇ NO ₇	Galactose- <i>o</i> -carboxyanilide.....	MeOH	1.16	20	4.3†	(968)
C ₁₃ H ₁₉ NO ₅	Galactose- <i>p</i> -toluidide.....	MeOH	0.9832	21	−10.91	(1976)
C ₁₄ H ₂₈ N ₂ O ₁₄ .2H ₂ O	Galactamine normal oxalate.....	H ₂ O	8		−11.28	(1802)
C ₁₆ H ₂₅ NO ₅	Tetramethylgalactoseanilide.....	Me ₂ CO	1.0	20	37.7†	(975)
C ₁₈ H ₂₂ N ₄ O ₄	Galactosazone.....	Py	0.8	19	121	
C ₂₄ H ₄₀ N ₂ O ₁₀	<i>asym.</i> -Di-(diacetonegalactosyl)-hydrazine...	C ₂ H ₂ Cl ₄	5.58	15	−77†	(669)
C ₄₈ H ₇₆ N ₄ O ₂₀	Tetra-(diacetonegalactosyl)-tetrazone.....	C ₂ H ₂ Cl ₄	3.29	15	−76.3†	(669)
Other hexoses						
C ₆ H ₁₂ O ₆	Cocaoase.....	H ₂ O	3.98	15	19.8	(895)
C ₁₆ H ₁₈ NO ₁₀	Epichitosamine pentaacetate.....	CHCl ₃	3	20	−18	(1224)
SUGAR ACIDS CONTAINING 6 CARBON ATOMS						
Acids derived from methylpentoses						
C ₆ H ₁₀ O ₅	Isorhammonic acid lactone.....	H ₂ O	8.903	20	−62.02	(510)
C ₆ H ₁₀ O ₅	Fuconic acid lactone.....	H ₂ O	1.64		78.3	(1479)
C ₄₁ H ₃₃ NO ₁₀	Pentabenzoylxylohexosamine.....	Py	2.83	20	77.6	(1222)
Gluconic acid and related compounds						
C ₆ H ₁₂ O ₆	Glucodesonic acid (H(CHOH) ₄ .CH ₂ .COOH)	H ₂ O	4.68	17	4.30	(112)
	Barium salt.....	H ₂ O	1.10	19	13.37	(112)
C ₆ H ₈ O ₅	Anhydrogluconic lactone.....	H ₂ O	9.13	20	82.3	(560)
C ₆ H ₁₀ O ₆	<i>d</i> -Gluconic α -lactone.....	H ₂ O	4.00	20	67.8	(844); cf. (456.5, 857.5)
	<i>d</i> -Gluconic β -lactone.....	H ₂ O	4.55	20	63.4	

* Calculated on weight of acid. † Mutarotation. ‡ [α]₄₄₅.

Gluconic acid and related compounds.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₆ H ₁₁ NO ₅	Anhydrogluconic amide.....	H ₂ O	9.11	20	77.7	(560)
C ₆ H ₁₂ O ₇	<i>d</i> -Gluconic acid, calcium salt.....	H ₂ O	4.93	20	10.55	(1490)
	Sodium salt.....	H ₂ O	20.8	20	11.78	(1234)
C ₈ H ₁₆ O ₇	Ethyl <i>d</i> -gluconate (H(CHOH) ₅ .CO.OCC ₂ H ₅)..	H ₂ O	4	20	-1.0	(844)
C ₁₀ H ₁₈ O ₆	Tetramethylgluconic lactone.....	EtOH aq.	2.41		39.5*	(1733); cf. (962)
C ₁₄ H ₁₈ O ₁₀	Tetraacetyl- <i>d</i> -gluconic lactone.....	C ₆ H ₆	10.5	21	70.86	(1549)
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine <i>d</i> -gluconate.....	H ₂ O	2.4	20	-15.95	(1234)
<i>Galactonic acid</i>						
C ₆ H ₁₀ O ₆	Galactonic lactone.....	H ₂ O	0.786		-69.97	(1722); cf. (1226, 1881.5)
	Galactonic γ-lactone.....	H ₂ O	4.5	20	-76.97	(844)
	Hydrate.....	H ₂ O	4.5	20	-70.1	
C ₆ H ₁₂ O ₇	Galactonic acid.....	H ₂ O	1.1015		-57.57*	(1722)
	Sodium salt.....	H ₂ O	10.02	20	0.4	(1234)
C ₈ H ₁₂ O ₇ .2H ₂ O	Dimethylenegalactonic acid.....	H ₂ O	0.645		45.3	(334)
C ₁₀ H ₁₈ O ₆	<i>l</i> -2, 3, 5, 6-Tetramethylgalactonic lactone...	H ₂ O	1.413		-26.96*	(1722)
	<i>d</i> -2, 3, 5, 6-Tetramethylgalactonic lactone...	H ₂ O	1.202		16.9*	
C ₁₁ H ₂₂ O ₇	Methyl <i>d</i> -2, 3, 5, 6-tetramethylgalactonate...	H ₂ O	1.773		9.93	(1722)
C ₁₄ H ₁₈ O ₁₀	Tetraacetyl- <i>d</i> -galactonic lactone.....	C ₆ H ₆	13.19	20	1.04	(1722)
	(Prepared by another method).....	C ₆ H ₆	17.47	20	8.5	
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine galactonate.....	H ₂ O	2.5	20	-21.01	(1234)
<i>Isomers of gluconic and galactonic acids</i>						
C ₆ H ₁₀ O ₆	Chitic acid.....	H ₂ O	3	0	63.0	(1227)
	Calcium salt.....	H ₂ O	3	17	63.0	(1227)
C ₆ H ₁₂ O ₇	Allonic acid.....	H ₂ O	2.5	20	-10.0	(1226)
	Sodium salt.....	H ₂ O	10.02	20	4.3	(1234)
C ₆ H ₁₂ O ₇	Altronic acid.....	H ₂ O	2.5	20	-8.0	(1226)
	Sodium salt.....	H ₂ O	7.78	20	-4.05	(1234)
C ₆ H ₁₂ O ₇	Chitonic acid.....	H ₂ O	3	8.5	38.3	(1227)
	Calcium salt.....	H ₂ O	3	17	30.3	(1227); cf. (1234)
C ₆ H ₁₂ O ₇	Gulonic acid.....	H ₂ O	2.5	0	1.6	(1226)
	Sodium salt.....	H ₂ O	9.38	20	12.68	(1234)
C ₆ H ₁₂ O ₇	Idonic acid, sodium salt.....	H ₂ O	8.22	20	-2.52	(1234)
C ₆ H ₁₂ O ₇	Mannonic acid.....	H ₂ O	2.5	0	15.6	(1226); cf. (514, 1061)
	Sodium salt.....	H ₂ O	9.52	20	-8.82	(1234)
C ₇ H ₁₀ O ₆	Monomethylene- <i>d</i> -mannonic acid lactone...	H ₂ O	1.022		91	(334)
C ₂₉ H ₃₆ N ₂ O ₁₀ †	Brucine chitarate.....	H ₂ O	2.5	20	-2.96	(1234)
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine allonate.....	H ₂ O	2.5	0	-21.28	(1234)
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine altronate.....	H ₂ O	2.477	20	-23.85	(1234)
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine chitonate.....	H ₂ O	2.5	20	-8.47	(1234)
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine gulonate.....	H ₂ O	2.6	20	-19.59	(1234); cf. (1226)
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine idonate.....	H ₂ O	2.5	20	-25.79	(1234)
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine mannonate.....	H ₂ O	2.6	20	-25.7	(1234)
C ₂₉ H ₃₈ N ₂ O ₁₁	Brucine talonate.....	H ₂ O	2.5	20	-26.15	(1234)
<i>Glucuronic acid and isomers</i>						
C ₆ H ₁₀ O ₇	Glucuronic acid, potassium salt (CHO.(CHOH) ₄ .COOK).....	H ₂ O	3.85	18	21.25	(225, 1138.8, 2008)
C ₁₂ H ₁₄ O ₇	Phenylglucuronate (CHO.(CHOH) ₄ .CO.OCC ₆ H ₅).....	EtOH	3.00	17	-83.3	(1507)
C ₁₃ H ₁₄ O ₈	Benzoylglucuronic acid, sodium salt.....	H ₂ O	3.25	20	43.86	(1358)
C ₁₆ H ₂₈ O ₇	Mentholglucuronic acid.....	EtOH	0.765	20	104.1	(482)
		EtOH	4.72	18	51.9	(113)
C ₁₉ H ₁₈ O ₁₁	Isoeuxanthic acid.....	70% EtOH	0.613		-87.4	(1507)
	Euxanthic acid†.....	70% EtOH	0.482		-108	

* Mutarotation. † For brucine anhydrotalonate, anhydrogalactonate and lyxohexosamate, see p. 474.



Saccharic and saccharinic acids and isomers

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₆ H ₈ O ₆ ·H ₂ O	Saccharone.....	H ₂ O	12.41	18	-6.1	(1057)
C ₆ H ₈ O ₇	<i>r</i> -Saccharic acid lactone.....	H ₂ O	18	18	40.77	(1421); <i>cf.</i> (264, 1974)
	<i>d</i> -Ammonium salt.....	H ₂ O	20.03		5.84	(1974)
C ₆ H ₈ O ₇	Isosaccharic acid lactone.....	H ₂ O	4.266	20	46.12	(2024)
C ₆ H ₈ O ₇ ·2H ₂ O	<i>d</i> -Mannosaccharic acid anhydride.....	H ₂ O	3.432	23	201.8	(457)
C ₆ H ₁₀ N ₂ O ₆	Isosaccharic diamide anhydride.....	H ₂ O	5		7.16	(2024)
	Saccharine (glucosaccharinic acid lactone)...	H ₂ O	10.4	20	88.7*	(1881)
		H ₂ O	12.08	17.5	93.08	(1596); <i>cf.</i> (854, 1861)
C ₆ H ₁₀ O ₅	Metasaccharin (from calcium metasaccharinate (C ₆ H ₁₁ O ₆) ₂ Ca·2H ₂ O).....	H ₂ O	7.846	14	-48.4	(1058)
		H ₂ O	7.0		-46.96	(1881)
	Isosaccharin (from calcium isosaccharinate)	H ₂ O	9.47		61.88	(2158)
		H ₂ O	10	10	62.97	(1881)
C ₆ H ₁₀ O ₈	Talomucic acid.....	H ₂ O	3.84	20	-29.4	(460)
C ₆ H ₁₀ O ₈	<i>r</i> -Saccharic acid ((CHOH) ₄ (COOH) ₂).....	H ₂ O	18	18	9.05	(1421)
C ₁₀ H ₁₆ O ₇	Diethyl isosaccharide anhydride.....	H ₂ O	5		35.5	(2027)
<i>Amino acids</i>						
C ₆ H ₁₃ NO ₆	<i>l</i> -Glucosamic acid (H(CHOH) ₄ ·CHNH ₂ ·COOH).....	2.5% HCl	8.82	18	14.31	(522)
C ₆ H ₁₃ NO ₆	<i>d</i> -Chondrosamic acid.....	2.5% HCl	4	20	-16.15	(1223)
	After addition of <i>M</i> Py.....	2.5% HCl	4	20	-4.83	
	<i>d</i> -Glucosamic acid.....	2.5% HCl	4	20	-15.02	
	After addition of <i>M</i> Py.....	2.5% HCl	4	20	2.11	
C ₆ H ₁₃ NO ₆	<i>d</i> -Lyxohexosamic acid.....	2.5% HCl	4	20	-3.58	
	After addition of <i>M</i> Py.....	2.5% HCl	4	20	-6.98	
	<i>d</i> -Xylohexosamic acid.....	2.5% HCl	4	20	11.77*	
	After addition of <i>M</i> Py.....	2.5% HCl	4	20	15.47	
SUGARS, ETC., CONTAINING 7 CARBON ATOMS						
<i>Acids with 7 carbon atoms</i>						
C ₇ H ₁₀ O ₆	Rhamnoheptonic acid anhydride.....	H ₂ O	10.036	20	55.6	(1971)
C ₇ H ₁₀ O ₈	β-Pentahydroxypimelic acid anhydride.....	H ₂ O	9.972	20	68.5	(461)
C ₇ H ₁₂ O ₆	Fucohexonic lactone.....	H ₂ O	1.56		33.3	(1408)
C ₇ H ₁₂ O ₇	α-Glucoheptonic lactone.....	H ₂ O	10	25	-43.73*	(1616); <i>cf.</i> (1059)
	β-Glucoheptonic lactone.....	H ₂ O	10	23	-67.9	(1616)
C ₇ H ₁₂ O ₇	<i>d</i> -Mannoheptonic acid anhydride.....	H ₂ O	10.01	20	-74.23	(1369)
C ₇ H ₁₂ O ₉	α-Pentahydroxypimelic acid.....	H ₂ O	10		0	(461)
C ₇ H ₁₄ O ₇	Rhamnohexonic acid.....	H ₂ O	10.03	20	83.8	(530)
C ₇ H ₁₄ O ₈	Mannoheptonic acid.....	H ₂ O	5.27	20	75.15	(1971)
C ₇ H ₁₅ NO ₇	Chondrosaminoheptonic acid.....	2.5% HCl	2.428	20	-14.4*	(1221)
C ₇ H ₁₆ NO ₇	Galaheptosamic acid.....	5% HCl	8.76	20	11.23	(522)
C ₇ H ₁₅ O ₈	<i>d</i> -Galactoseheptonic acid, barium salt.....	H ₂ O	12.01	20	5.50	(1369)
<i>Sugars with 7 carbon atoms and derivatives</i>						
C ₇ H ₁₄ O ₆	Rhamnohexose.....	H ₂ O	9.675	20	-61.4*	(530)
C ₇ H ₁₄ O ₇	α-Glucoheptose.....	H ₂ O	10	20	-25*	(461)
	β-Glucoheptose.....	H ₂ O	5.125	20	-12.2	(1616)
C ₇ H ₁₄ O ₇	β-Galaheptose.....	H ₂ O	9.2	20	-54.4*	(466)
C ₇ H ₁₄ O ₇	Mannoheptose.....	H ₂ O	10.807	20	68.64*	(529); <i>cf.</i> (1971)
C ₇ H ₁₄ O ₇	<i>d</i> -Mannoheptose.....	H ₂ O	18.8	20	29.37	(1159)
C ₇ H ₁₄ O ₇	Perseulose.....	H ₂ O	10	25	-81	(129)
C ₁₉ H ₂₆ O ₁₃	α-Glucoheptose β-hexaacetate.....	CHCl ₃		20	4.8	(951)
	α-Glucoheptose α-hexaacetate.....	CHCl ₃		20	87.0	
C ₁₉ H ₂₆ O ₁₃	Hexaacetyl- <i>d</i> -α-mannoheptose (isomer a)....	CHCl ₃	5.59	20	24.4	(948)
	(Isomer b).....	CHCl ₃	0.982	20	-31	
<i>Heptahydric alcohols</i>						
C ₇ H ₁₆ O ₇	β-Glucoheptitol.....	H ₂ O			0.80	(1614)
		H ₂ O	10	10	48.0	(1616)
		5% Borax	10	10	-50*	

* Mutarotation.

Heptahydric alcohols.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₂₁ H ₃₀ O ₁₄	Heptaacetyl β -glucoheptitol.....	EtOH	10	13	34.8	(1616)
SUGARS, ETC., CONTAINING 8 CARBON ATOMS						
C ₈ H ₁₄ O ₈	Galactooctonic lactone.....	H ₂ O	4.26	20	64.0	(530)
C ₈ H ₁₄ O ₈	α , α -Glucooctonic lactone.....	H ₂ O	10.0	22	47.05*	(1616)
	α , β -Glucooctonic lactone.....	H ₂ O	8	17	24.1	
C ₈ H ₁₄ O ₈	α -Glucooctonic acid anhydride.....	H ₂ O	10.405	20	45.9	(461)
	β -Glucooctonic acid anhydride.....	H ₂ O	11.399	20	23.6	
C ₈ H ₁₄ O ₈	Mannooctonic acid anhydride.....	H ₂ O	9.85	20	-43.58	(529)
C ₈ H ₁₆ O ₇	Rhamnoheptose.....	H ₂ O	9.40	20	8.4	(461)
C ₈ H ₁₆ O ₈	α , α -Glucooctose (α -form).....	H ₂ O	7.25	18	-93 to	(1616)
		H ₂ O	6.496	20	-50.8	
	α , α -Glucooctose (β -form).....	H ₂ O	1.8		-50.5	(461)
C ₈ H ₁₈ O ₈	α , α -Glucooctitol.....	H ₂ O	10.0	15	-28	(1616)
					1.9	(1616)
SUGARS, ETC., CONTAINING 9 CARBON ATOMS						
C ₉ H ₁₆ O ₈	Rhamnooctonic acid anhydride.....	H ₂ O	4.762	20	-50.8	(530)
C ₉ H ₁₆ O ₉	α -Glucnononic acid anhydride.....	H ₂ O	10	20	33	(461)
C ₉ H ₁₆ O ₉	Mannononic acid anhydride.....	H ₂ O	10.00	20	-41.0	(529)
C ₉ H ₁₆ O ₉	α , α , α -Glucnononic lactone.....	H ₂ O	10.0		28.7*	(1616)
C ₉ H ₁₈ O ₉	α , α , α -Glucnonose.....	H ₂ O	11.6	15	13.5	(1616)
C ₉ H ₂₀ O ₉	α , α , α -Glucnonitol.....	H ₂ O	1.5	15	1.5	(1616)
SUGARS, ETC., CONTAINING 10 CARBON ATOMS						
C ₁₀ H ₁₈ O ₁₀ .H ₂ O	α -Deconic lactone hydrate.....	H ₂ O	6.0	20	-41.0*	(1616)
	β -Deconic lactone hydrate.....	H ₂ O	5.0	17	-28.0*	
C ₁₀ H ₂₀ O ₁₀	α , α , α -Glucodecose.....	H ₂ O	10.0	20	50.4*	(1615, 1616)
C ₁₀ H ₂₂ O ₁₀	α -Glucodecitol.....	H ₂ O	2.0	20	1.2	(1615, 1616)
C ₂₀ H ₃₈ O ₂₁	β -Deconic anhydride.....	H ₂ O	1.2	13	-20.4*	(1616)
C ₃₀ H ₄₂ O ₂₀	Decaacetyl- α -glucodecitol.....	CHCl ₃	5.0	18	16.0	(1615, 1616)
SUGARS, ETC., CONTAINING 12 CARBON ATOMS						
<i>Derivatives of saccharose</i>						
C ₁₉ H ₃₆ O ₁₁	Heptamethylsaccharose.....	MeOH	5.585		68.5	(837)
C ₂₀ H ₃₈ O ₁₁	Octomethylsaccharose.....	MeOH	5.15	20	51.5	(1735)
		MeOH	7.345		69.3	(837)
		Me ₂ CO	6.782		66.8	
<i>Lactal, lactose and derivatives</i>						
C ₁₂ H ₂₀ O ₉	Lactal $\left(\begin{array}{c} \text{C}_6\text{H}_{11}\text{O}_5\text{O} \\ \text{HO.CH}_2\text{CH.CH.CHOH.CH:CH} \end{array} \right)$	H ₂ O	9.38	16	27.70	(111.5)
	Boiled in H ₂ O.....	H ₂ O			36.43	
		H ₂ O	1.01	22	28.53	(497)
	Calc. as hydrate.....	H ₂ O	1.01	22	26.95	
		H ₂ O	9.93	19	26.92	
C ₂₂ H ₃₀ Br ₂ O ₁₃	Dibromo- ψ -lactal pentaacetate.....	C ₂ H ₂ Cl ₄	4.25	23	69.6	(111.5)
C ₂₂ H ₄₀ O ₁₁	<i>l</i> -Menthyl- β -lactoside.....	H ₂ O	1.109	16	-38.11	(482)
		H ₂ O	1.251	16	-37.97	
C ₂₄ H ₃₀ Br ₂ O ₁₃	Dibromolactal hexaacetate.....	C ₂ H ₂ Cl ₄	6.10	18	135.5	(497)
C ₂₄ H ₃₂ O ₁₅	Lactal hexaacetate.....	C ₂ H ₂ Cl ₄	7.54	19	-12.27	(497)
C ₂₄ H ₃₂ O ₁₅	ψ -Lactal hexaacetate.....	C ₂ H ₂ Cl ₄	8.8	18	32.24	(111.5)
	Isolactal hexaacetate.....	C ₂ H ₂ Cl ₄	5.83	23	55.30	
C ₂₆ H ₃₆ BrO ₁₇	Bromolactose heptaacetate.....	CHCl ₃	3.80	14	108.17	(388)
C ₂₆ H ₃₆ O ₁₈	Lactose heptaacetate.....	CHCl ₃			52.8	(950)
C ₃₆ H ₅₄ O ₁₈	Heptaacetyl- <i>l</i> -menthyl- β -lactoside.....	C ₂ H ₂ Cl ₄	11.18	19	-29.66	(482)
<i>Maltose and derivatives (including amygdalin)</i>						
C ₁₄ H ₂₆ O ₁₁	Ethylmaltoside.....	H ₂ O	7.03	16.5	79.22	(518)
C ₁₈ H ₂₆ O ₁₁	β -Phenylmaltoside.....	H ₂ O	5.1	20	34.0	(490)
C ₁₉ H ₂₇ NO ₁₂	Maltose- <i>o</i> -carboxyanilide.....	MeOH	0.919	20	68*	(968)
C ₁₉ H ₂₈ O ₁₁	Benzylmaltoside.....	H ₂ O	4.85	17	47.64	(518)
C ₂₀ H ₂₇ NO ₁₁	Amygdalin (C ₁₂ H ₂₁ O ₁₀ .O.CH(CN).C ₆ H ₅).....	H ₂ O	2.124		-38.0	(2047)
		H ₂ O	4	17	-37.25	(1141)
C ₂₄ H ₂₃ O ₁₅	Maltal hexaacetate.....	C ₂ H ₂ Cl ₄	3.38	16.5	64.2	(518)
C ₂₆ H ₃₈ O ₁₈	Methylmaltoside heptaacetate.....	CHCl ₃	6.0	20	53.8	(950)

* Mutarotation.

Maltose and derivatives (including amygdalin).—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₂₆ H ₃₅ BrO ₁₇	Bromomaltose heptaacetate.....	CHCl ₃	37.9	19	171.5	(518)
C ₂₆ H ₃₅ NO ₂₀	Maltose nitrate heptaacetate.....	CHCl ₃	5.27	19	149.30	(1119)
		C ₂ H ₂ Cl ₄	6.08	10	103.0*	(518)
C ₂₆ H ₃₆ O ₁₈	Maltose heptaacetate.....	CHCl ₃		20	110*	(950)
		C ₂ H ₂ Cl ₄		20	95.4*	
C ₂₈ H ₃₈ O ₁₉	α-Maltose octaacetate.....	MeOH	5.06	20	121.25	(946)
		MeOH	10.07	20	120.25	
		CHCl ₃	5.01	20	122.75	
		CHCl ₃	9.94	20	121.95	
		C ₆ H ₆	5.00	20	124.05	
		C ₆ H ₆	9.93	20	123.1	
		99.5% Me ₂ CO	3.95	20	124.3	
		50% Me ₂ CO	10.12	20	124.25	
C ₂₈ H ₃₈ O ₁₉	β-Maltose octaacetate.....	CHCl ₃	5.09	20	62.5	(946)
		CHCl ₃	10.61	20	62.9	
		C ₆ H ₆	5.20	20	74.85	
		C ₆ H ₆	10.26	20	74.5	
		Me ₂ CO	5.45	20	54.8	
		Me ₂ CO	10.43	20	57.4	
C ₂₈ H ₃₈ O ₁₉	Maltose octaacetate.....	C ₆ H ₆	2		76.54	(857); cf.
		CHCl ₃	2		61.01	(859,
		EtOH	1		60.02	860)
C ₂₈ H ₄₀ O ₁₈	Ethylmaltoside heptaacetate.....	C ₂ H ₂ Cl ₄	3.72	14	48.93	(518)
C ₃₃ H ₄₂ O ₁₈	Benzylmaltoside heptaacetate.....	C ₂ H ₂ Cl ₄	6.92	16.5	27.7	(518)
C ₃₄ H ₄₁ NO ₁₈	Heptaacetylamygdalin.....	CHCl ₃	2.037		-37.6	(2047)
		AcOEt	2.026		-34.0	
		CHCl ₃	2.211		-65.6	
		AcOEt	2.218		-57.1	
<i>Cellose, cellobial, cellobiose and derivatives</i>						
C ₁₂ H ₂₀ O ₉	Cellobial.....	H ₂ O	8.744	20	1	(502)
C ₁₂ H ₂₂ O ₉	Hydrocellobial.....	H ₂ O	9.374	21	4.1	(502)
C ₂₄ H ₃₂ O ₁₅	Cellobial hexaacetate.....	C ₂ H ₂ Cl ₄	6.753	17	-19.8	(502)
C ₂₄ H ₃₂ Br ₂ O ₁₃	Cellobial dibromide hexaacetate.....	C ₂ H ₂ Cl ₄	6.424	20	57.9	(502)
		C ₂ H ₂ Cl ₄		20	57.4	
C ₂₄ H ₃₄ O ₁₅	Hydrocellobial hexaacetate.....	C ₂ H ₂ Cl ₄	5.912	19	11.2	(502)
C ₂₅ H ₃₈ O ₁₈	Methylcelloside heptaacetate.....	CHCl ₃	4.55	20	-25.4	(950)
C ₂₆ H ₃₅ ClO ₁₇	Chlorocellobiose heptaacetate.....	CHCl ₃	2.75	20	74.87	(1961)
C ₂₆ H ₃₅ FO ₁₇	Fluorocellobiose heptaacetate.....	CHCl ₃	4.08	20	30.03	(231)
C ₂₆ H ₃₆ O ₁₈	Cellose heptaacetate.....	CHCl ₃			22.6*	(950)
C ₂₈ H ₃₈ O ₁₉	α-Cellose octoacetate.....	CHCl ₃	5	20	40.85	(946)
		CHCl ₃	10	20	41.95	
	β-Cellose octoacetate.....	CHCl ₃	5	20	-14.75	
		CHCl ₃	10	20	-14.5	
C ₃₃ H ₄₀ O ₁₉	β-Benzoylcellobiose heptaacetate.....	CHCl ₃	4.50	20	-30.5	(2241)
C ₃₃ H ₄₀ O ₂₀	β-Salicylcellobiose heptaacetate.....	CHCl ₃	3.35	20	-43.43	(2241)
C ₃₅ H ₄₃ NO ₂₀	Hippurylcellobiose heptaacetate.....	CHCl ₃	3.37	20	-15.04	(2241)
<i>Gentiobiose and derivatives</i>						
C ₂₀ H ₃₈ O ₁₁	Heptamethylmethylgentiobioside.....	H ₂ O			-33.9	(842.5)
		EtOH			-29.9	
		MeOH			-30.0	
		Me ₂ CO	0.57		-27.0	
C ₂₄ H ₃₂ N ₄ O ₉	Gentiobiose osazone.....	40% Py in EtOH	1.523	20	-76.1	(2238,
						2239)
C ₂₈ H ₃₈ O ₁₉	Gentiobiose octoacetate.....	CHCl ₃	1.723	20	-5.3	(2238,
						2239)
<i>OTHER DISACCHARIDES AND POLYSACCHARIDES</i>						
(C ₆ H ₁₀ O ₅) _n	Levulomannan.....	very dil. KOH	2.0		-44.1	(72)
(C ₆ H ₁₀ O ₅) _n	Mannogalactan.....	H ₂ O	3.15		74.2	(72)
C ₁₀ H ₁₇ NO ₆	Phaseolunatine.....	H ₂ O	7.009	28	-27.7	(743)
C ₁₁ H ₂₀ O ₁₀	Vicianose.....	H ₂ O	8	20	39.72*	(135); cf.
						(130)
C ₁₂ H ₁₄ Cl ₄ O ₁₁ S ₂	Trehalose tetrachlorohydrine disulfate.....	CHCl ₃	3.21	17	151.9	(848)
		CHCl ₃	2.75	20	152.3	

* Mutarotation

OTHER DISACCHARIDES AND POLYSACCHARIDES.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₂ H ₂₀ O ₁₀ ·2H ₂ O	Diamylose.....	H ₂ O	0.6375	24	136.2	(1721)
C ₁₂ H ₂₀ O ₁₀	Isodiamylose.....	50% EtOH	1.034	24	136.4	
C ₁₂ H ₂₂ O ₉	Hydrolactal.....	H ₂ O	3.16	24	168.3	(1719)
C ₁₂ H ₂₂ O ₉	Cyclamose.....	H ₂ O	9.67	20	28.38	(497)
					-15.15	(1423); <i>cf.</i> (1399)
C ₁₂ H ₂₂ O ₁₁	5-Galactosidomannose.....	HCl dil.			-66.54	
C ₁₂ H ₂₂ O ₁₁	Galactobioses (A).....	H ₂ O	1.20	23	23.04	(111.5)
		H ₂ O		16	53.05	(187)
		90% EtOH		19	39.3	(182)
		40% EtOH		19	49.0	
	(B).....	H ₂ O			35.0	(188); <i>cf.</i> (186)
C ₁₂ H ₂₂ O ₁₁	Melibiose.....	H ₂ O	17.3	20	143.27	(95)
C ₁₂ H ₂₂ O ₁₁	Verbascose.....	H ₂ O	1.324		169.9	(189.5)
C ₁₆ H ₂₀ O ₉	Gentiopierin.....	H ₂ O?	0.394		-196.7	(243)
		AcOEt	6.094		-196.9	(189); <i>cf.</i> (245)
C ₁₈ H ₂₂ N ₂ O ₄	Apiose phenylhydrazone.....	H ₂ O	3.40	20	3.8	(2076)
C ₁₈ H ₃₀ O ₁₅ ·4H ₂ O	Triamylose.....	H ₂ O	0.9479	24	151.4	(1721)
		H ₂ O	0.9913	24	151.8	
C ₁₈ H ₃₀ O ₁₅	Isotriamylose.....	H ₂ O	2.81	24	172.8	(1719)
C ₂₀ H ₃₈ O ₁₁	Octamethylglucosidoglucoside.....	MeOH	6.23	20	135.9	(1735)
C ₂₁ H ₂₄ O ₉	Rhapontin.....	50% Me ₂ CO	2	15	-63.0	(897)
C ₂₄ H ₃₂ N ₄ O ₉	Galactoarabinose benzylphenylhydrazone..	50% EtOH	1.67		-23.7	(1808)
C ₂₄ H ₃₂ O ₁₆	Diamylose hexaacetate.....	AcOH	5.969	24	100.6	(1721)
		AcOH	2.03	20	101.6	(1719)
C ₂₄ H ₃₂ O ₁₆	Isodiamylose hexaacetate.....	AcOH	2.44	24	128.9	(1719)
C ₂₄ H ₄₀ O ₂₀ ·2EtOH	α-Dextrin (tetraamylose).....	H ₂ O	0.8549	24	138.6	(1721)
C ₂₄ H ₄₂ O ₁₆	Hexamethyltriomylose.....	EtOH	2.12	20	138.1	(1720)
C ₂₄ H ₄₂ O ₂₁ ·H ₂ O	Lupeose.....	H ₂ O	5	22	138	(1910, 1984)
C ₂₄ H ₄₂ O ₂₁	Manneotetrose.....	H ₂ O	10		150	(2002)
C ₂₅ H ₂₈ O ₁₂	Dibenzoylglucoxylose.....	MeOH	1.05		-105.9	(2050)
	Isodibenzoylglucoxylose.....	MeOH	1.05		-6.3	
C ₃₁ H ₃₄ O ₁₄	Pentaacetyl-rhapontin.....	AcOH	2	15	-11.6	(897)
C ₃₆ H ₄₈ O ₂₄	Triamylose nonoacetate.....	AcOH	2.966	24	112.4	(1721)
C ₃₆ H ₄₈ O ₂₄	Isotriamylose nonoacetate.....	AcOH	2.38	24	130.1	(1719)
C ₃₆ H ₆₀ O ₃₀ ·9H ₂ O	β-Dextrin (hexaamylose).....	H ₂ O	1.087	24	158.3	(1721)
C ₃₆ H ₆₄ O ₃₂	Stachyose.....	H ₂ O	9		148.1	(98, 1484, 2245)
C ₃₇ H ₃₆ O ₂₀	Scroton octaacetate.....	CHCl ₃	1.003		-76.4	(1698)
C ₄₈ H ₈₄ O ₃₀	Dodecamethyl-β-hexaamylose.....	EtOH	4.13	20	142.9	(1720)
	Dodecamethyl-α-hexaamylose.....	EtOH	2.08	20	148.73	

IC₁. The Molecule Contains One Asymmetric Atom Attached to Three Other Carbon Atoms

HYDROCARBONS AND THEIR HALOGEN DERIVATIVES

C ₅ H ₁₁ Br	<i>d</i> -Amyl bromide (CH ₃ .CH ₂ .CH(CH ₃).CH ₂ Br)	1.221	20	3.68	(1377)
C ₅ H ₁₁ I	<i>d</i> -Amyl iodide (CH ₃ .CH ₂ .CH(CH ₃).CH ₂ I)...	1.524	20	5.64	(1377)
		1.5232	15	5.78	(1091)
C ₆ H ₁₃ Br	γ-Methyl- <i>n</i> -amyl bromide (CH ₃ .CH ₂ .CH(CH ₃).CH ₂ .CH ₂ .Br).....	1.1852 ¹⁹	19	19.97	(827)
	And at intermediate temperatures.....	1.0319 ¹⁴²	142	13.97	
C ₇ H ₁₆	<i>d</i> -Methylethylpropylmethane.....	0.6865	20	9.5	(1377)
C ₁₂ H ₁₆	α-Phenyl-γ-methyl-Δ ^α -pentene (C ₆ H ₅ .CH:CH.CH(CH ₃).CH ₂ .CH ₃).....	0.8906	15	50.3	(1091)
C ₁₂ H ₁₈	α-Phenyl-γ-methylpentane (C ₆ H ₅ .CH ₂ .CH ₂ .CH(CH ₃).CH ₂ .CH ₃).....	0.8644	14.5	17.20	(1091)
		0.7396	168	13.66	(827)
C ₁₂ H ₁₆ Br ₂	α-Phenyl-α, β-dibromo-γ-methylpentane (C ₆ H ₅ .CHBr.CHBr.CH(CH ₃).CH ₂ .CH ₃)...	0.127	15	32.1	(1091)
C ₁₅ H ₂₂	Δ ^α -γ-Methylpentenyl- <i>p</i> -isopropylbenzene (C ₃ H ₇ .C ₆ H ₄ .CH:CH.CH(CH ₃).CH ₂ .CH ₃)...	0.8801 ¹⁵	16	41.89	(1092)
C ₁₅ H ₂₄	γ-Methylpentan-yl- <i>p</i> -isopropylbenzene (C ₃ H ₇ .C ₆ H ₄ .CH ₂ .CH ₂ .CH(CH ₃).CH ₂ .CH ₃)..	0.8632 ^{15.5}	15.5	15.91	(1092)

HYDROCARBONS AND THEIR HALOGEN DERIVATIVES.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₆ H ₂₄	γ , η -Dimethyl- Δ^7 -octenylbenzene (C ₆ H ₅ .CH ₂ .CH ₂ .CH(CH ₃).CH ₂ .CH ₂ .CH ₂ .- C(CH ₃):CH ₂).....		0.8844 ₄ ^{11.6}	11.5	-7.26	(1093)
C ₁₆ H ₂₆	γ , η -Dimethyloctylbenzene (C ₆ H ₅ .CH ₂ .CH ₂ .CH(CH ₃).CH ₂ .CH ₂ .CH ₂ .- CH(CH ₃) ₂).....		0.8789 ₄ ^{10.6}	10.5	-1.82	(1093)
C ₁₇ H ₂₄	2, 6-Dimethyl- Δ^2 -nonadiene-9-benzene (C ₆ H ₅ .CH:CH.CH ₂ .CH(CH ₃).CH ₂ .CH ₂ .- CH:C(CH ₃) ₂).....		0.8894	20	-3.33	(1814)
ALCOHOLS AND THEIR DERIVATIVES						
<i>Amyl alcohol and derivatives, homologues and esters</i>						
C ₈ H ₁₄ O	γ -Methyl- <i>n</i> -amyl alcohol (CH ₃ .CH ₂ .CH(CH ₃).CH ₂ .CH ₂ OH).....		0.8262 ^{20.5}	20.5	8.77	(827)
	And at intermediate temperatures.....		0.7276 ¹⁴⁷	147	6.10	
C ₈ H ₁₄ O ₂	<i>d</i> -Amyl pyruvate.....			13	4.7	(1344.5)
C ₁₂ H ₁₆ O ₅	<i>d</i> -Amyl gallate.....			17	4.0	(1344.5)
C ₁₂ H ₁₇ NO ₂	<i>d</i> -Amyl phenylcarbamate.....	CHCl ₃	5		6.4	(1377)
C ₁₃ H ₁₅ NO ₂	<i>d</i> -Amylphthalimide.....		1.0930	25	7.53	(1377)
C ₁₃ H ₁₅ NO ₆	α - <i>l</i> -Amyl β -hydrogen γ -nitrophthalate.....	Me ₂ CO	10	17	6.5	(1379)
C ₁₃ H ₁₅ NO ₆	β - <i>d</i> -Amyl hydrogen γ -nitrophthalate.....	Me ₂ CO	10		2.6	(1376)
C ₁₃ H ₁₆ O ₃	<i>d</i> -Amyl benzoylformate.....			19	4.1	(1344.5)
C ₂₂ H ₂₄ O ₂	Amyl α -phenylcinnamylacrylate.....	EtOH	9.97	20	3.87	(1821)
C ₂₂ H ₂₆ O ₂	Amyl α , δ -diphenyl- $\Delta^{2,3}$ -pentenoate.....	EtOH	9.99	20	7.15	(1821)
	Amyl α , δ -diphenyl- $\Delta^{1,2}$ -pentenoate.....	EtOH	9.98	20	4.84	
<i>Linalool and citronellol</i>						
C ₁₀ H ₁₈ O	<i>l</i> -Linalool; cf. (79, 80, 1461) ((CH ₃) ₂ C:CH.CH ₂ .CH ₂ .- C(CH ₃)OH.CH:CH ₂).....		0.8622 ²⁰		-19.62	(2025)
C ₁₀ H ₂₀ O	<i>d</i> -Citronellol; cf. (80, 82.5, 125.05, 170, 407, 1385, 1444, 2030) ((CH ₃) ₂ C:CH.CH ₂ .CH ₂ .- CH(CH ₃).CH ₂ .CH ₂ OH).....		0.8618 ₁₆ ¹⁵		2.65	(1871.5)
			0.8565	17.5	4.0	(2029)
C ₁₀ H ₂₂ O	Tetrahydro- <i>l</i> -linalool ((CH ₃) ₂ C(CH ₂) ₃ .C(CH ₃)(OH).CH ₂ .CH ₃)...		0.836 ₁₇ ¹⁷	17	-24	(85)
C ₁₂ H ₂₄ O	Ethyl- α -citronellol.....				-11.26	(67)
C ₁₂ H ₂₄ O	Dimethyl- α , α -citronellol.....				-11.38	(67)
C ₁₂ H ₂₄ O ₂	Tetrahydrolinaloyl acetate.....		0.891 ₆ ⁴	17	-2.2	(85)
C ₁₃ H ₂₂ O	Linaloyl allyl ether (C ₁₀ H ₁₇ .O.C ₃ H ₆).....		0.8665 ₄ ^{16.4}		2.0	(814)
C ₁₄ H ₂₈ O	Diethyl- α , α -citronellol.....				-13.25	(67)
<i>Other alcohols and derivatives</i>						
C ₁₀ H ₂₀ O ₃	γ , δ -Dimethoxy- β - Σ -dimethylhexane- β - Σ -diol anhydride.....	Me ₂ CO	4.495	20	13.35	(1747)
C ₁₁ H ₂₂ O	β , δ -Dimethyl- Δ' -nonenol.....		0.8578	20	0.55	(1839)
C ₁₄ H ₁₄ O	<i>d</i> - α -Phenyl- α' - <i>p</i> -hydroxyphenylethane (C ₆ H ₅ .CH(CH ₃).C ₆ H ₄ OH).....	CHCl ₃	5.58		6.54	(1627)
		C ₆ H ₆	4.95		7.78	
C ₁₄ H ₂₀ O	α - <i>p</i> -Ethoxyphenyl- γ -methyl- Δ^{α} -pentene (C ₂ H ₅ O.C ₆ H ₄ .CH:CH.CH(CH ₃).CH ₂ .CH ₃)...		0.9406	15	40.97	(1092)
C ₁₄ H ₂₂ O	α - <i>p</i> -Ethoxyphenyl- γ -methylpentane (C ₂ H ₅ O.C ₆ H ₄ .CH ₂ .CH ₂ .CH(CH ₃).CH ₂ .CH ₃)...		0.9119	16	14.99	(1092)
C ₂₆ H ₃₃ NO ₃	<i>d</i> - α -Phenyl- α' - <i>p</i> -hydroxyphenylethane- <i>l</i> - menthylcarbamate.....	CHCl ₃	5.03		-41.8	(1627)
AMINES AND HYDRAZINES						
C ₆ H ₁₃ N	<i>d</i> -Amylamine (CH ₃ .CH ₂ .CH(CH ₃).CH ₂ .NH ₂)		0.7505	25	-5.86	(1377); cf. (828)
C ₁₂ H ₁₉ N	Methyl- <i>l</i> -amylaniline (CH ₃ .CH ₂ .CH(CH ₃).CH ₂ .N(CH ₃).C ₆ H ₅)...		0.9220	15	11.06	(1007)
C ₁₁ H ₁₈ N ₂	<i>d</i> -Phenylamylhydrazine (CH ₃ .CH ₂ .CH(CH ₃).CH ₂ .N(NH ₂).C ₆ H ₅)....		0.9521	room	4.75*	(1503)
KETONES AND ALDEHYDES AND THEIR CONDENSATION PRODUCTS						
C ₆ H ₁₀ O	<i>d</i> -Valeraldehyde (CH ₃ .CH ₂ .CH(CH ₃).CHO).		0.8068	20	23.56	(410)
C ₁₀ H ₁₈ O	Citronellal ((CH ₃) ₂ C:CH.CH ₂ .CH ₂ .CH- (CH ₃).CH ₂ .CHO).....		0.8538	17.5	12.50	(2029)
			0.8509	25	4.8	(389, 390)

* Increasing with time.

KETONES AND ALDEHYDES AND THEIR CONDENSATION PRODUCTS.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₁ H ₂₀ O	β, ξ-Dimethyl-Δ ^α -nonene-θ-one (CH ₃ .CO.CH ₂ .CH(CH ₃).CH ₂) ₃ .- C(CH ₃):CH ₂).....		0.8650	20	5.89	(1839)
C ₁₃ H ₂₂ O	Citronellideneacetone ((CH ₃) ₂ C:CH.CH ₂ .- CH ₂ .CH(CH ₃).CH ₂ .CH:CH.CO.CH ₃).....		0.8737	20	-2.70	(1836)
C ₁₂ H ₂₀ O ₂	Citronellideneacetic acid.....		0.9326	20	-6.49	(1836)
C ₁₃ H ₂₂ O ₂	Methyl citronellideneacetate.....	EtOH	9.718	20	-9.56	(1836)
ACIDS AND DERIVATIVES						
<i>Isovaleric acid and its homologues</i>						
C ₅ H ₁₀ O ₂	Isovaleric acid (<i>d</i> -methylethylacetic acid, CH ₃ .CH ₂ .CH(CH ₃).COOH).....		0.9471	16.5	17.95	(1700)
C ₆ H ₁₁ BrO ₂	<i>d</i> -α-Bromo-β-methylvaleric acid.....	C ₆ H ₆	9.99	24	18.2	(1706)
C ₉ H ₁₅ NO ₂	<i>d</i> -Cyanoisopropylvaleric acid.....	PhMe	9.85	20	26.48	(13)
C ₉ H ₁₅ O ₂	<i>d</i> -Propylisobutylacetic acid (C ₃ H ₇)CH.C ₄ H ₉ (COOH).....			22	9.80	(515)
				24.5	5.73	(515)
C ₁₀ H ₂₀ O ₂	<i>d</i> -Butylisobutylacetic acid.....	C ₆ H ₄ Me ₂	14.2	20	6.34	
	(C ₄ H ₉ .C(C ₄ H ₉) ₂ .COOH)	EtOH	13.7	20	5.98	
		N NaOH	10.1	20	7.13	
C ₁₀ H ₂₀ O ₂	Tetramethylcaproic acid.....	EtOH	2.53	17	45.9	(808)
C ₁₀ H ₂₁ NO	Tetramethylcaproic amide.....	EtOH	4.77	20	46.6	(808)
C ₁₆ H ₃₃ NO	α, α-Dipropyl-β, γ-dimethylcaprylic amide..	EtOH		18	18.32	(809)
<i>Aromatic acids</i>						
C ₉ H ₉ ClO ₂	<i>d</i> -α-Chloro-α-phenylpropionic acid.....	C ₆ H ₆	1.690	20	26.0	(1334)
C ₉ H ₉ ClO ₂	<i>l</i> -α-Phenyl-α-chloropropionic acid.....	C ₆ H ₆	7.188		-26.3	(1335)
C ₉ H ₁₀ O ₂	α-Phenylpropionic acid (C ₆ H ₅ .CH(CH ₃).COOH).....	EtOH	3.159	20	57.94	(1767)
		CHCl ₃	2.834	20	76.2	
C ₁₀ H ₁₁ ClO	<i>d</i> -Benzylmethylacetyl chloride.....	Et ₂ O	18.0		18	(1079)
					22.65	(1636)
C ₁₀ H ₁₂ O ₂	<i>d</i> -Benzylmethylacetic acid.....	CHCl ₃	3.282		27.7	
		C ₆ H ₆	3.732		27.1	
	Sodium salt.....	H ₂ O	2.226		35.9	(1636)
		H ₂ O	2		26	(1079)
C ₁₁ H ₁₂ O ₂	<i>d</i> -Phenylallylacetic acid.....	CHCl ₃	2.147		84.6	(1636)
		C ₆ H ₆	2.44		103.2	
	Sodium salt.....	H ₂ O	1.676		20.3	(1636)
C ₁₁ H ₁₄ O ₂	<i>d</i> -Benzylethylacetic acid.....	CHCl ₃	2.489		38.4	(1636)
		C ₆ H ₆	2.464		41.0	
	Sodium salt.....	H ₂ O	1.905		50.4	(1636)
C ₁₁ H ₁₄ O ₂	<i>d</i> -Phenylpropylacetic acid.....	C ₆ H ₆	2.935		72.10	(1636)
		C ₆ H ₆	2.935		79.1	
		CHCl ₃	4.047		58.8	
	Sodium salt.....	H ₂ O	1.599		140.7	(1636)
C ₁₅ H ₁₄ O ₂	<i>d</i> -α-Phenylhydrocinnamic acid (C ₆ H ₅ .CH ₂ .CH(C ₆ H ₅).COOH).....	C ₆ H ₆	10.1	20	94.04	(1834)
C ₁₆ H ₁₄ O ₃	<i>l</i> -β-Benzoyl-α-phenylpropionic acid (C ₆ H ₅ .CO.CH ₂ .CH(C ₆ H ₅).COOH).....	AcOEt	1.67		157.3	(825.5)
C ₁₈ H ₂₁ NO	<i>d</i> -Benzylmethylacet- <i>l</i> -phenylethylamide....	Et ₂ O	2.15		8.6	(1081)
C ₁₉ H ₂₁ NO	<i>d</i> -Benzylmethylacet- <i>d</i> -hydrindamide.....	MeOH	4.30		-15.5	(1081)
C ₂₀ H ₂₃ NO	<i>d</i> -Benzylmethylacet- <i>l</i> -methylhydrindamide..	CHCl ₃	2.04		-26.5	(1081)
C ₂₅ H ₃₂ O ₂	<i>l</i> -Menthyl <i>d</i> -α-phenylhydrocinnamate.....	C ₆ H ₆	10.02	20	-89.06	(1834)
	<i>l</i> -Menthyl <i>l</i> -α-phenylhydrocinnamate.....	C ₆ H ₆	9.97	20	-21.97	
<i>Hydroxy acids</i>						
C ₄ H ₇ BrO ₃	<i>d</i> -β-Bromo-α-methylactic acid (CH ₂ Br.C(CH ₃)(OH).COOH).....	H ₂ O	9.68	20	7.4	(1047)
C ₄ H ₇ O ₄ K	<i>d</i> -α-Methylglycerate (HO.CH ₂ .CH(CH ₂ OH).COOH).....	H ₂ O	9.85	20	-4.00	(1047)
C ₉ H ₁₀ O ₃	<i>d</i> -α-Phenyl-α-hydroxypropionic acid.....	EtOH	3.354	13.8	37.7	(1334)
	(C ₆ H ₅ .C(CH ₃)(OH).COOH)	Me ₂ CO	4.142	13	-36.5	
		H ₂ O	2.160	14.5	-51.1	
		H ₂ O	1.589	13	-52.5	
		H ₂ O	0.688	14.5	-53.8	

Hydroxy acids.—(Continued)

Formula	Name	Solvent	d , C or %	t , °C	$[\alpha]_D$	Lit.
$C_9H_{10}O_3$	d -Tropic acid ($C_6H_5.CH.(CH_2OH).COOH$)	EtOH	2.69	16	72.2	(1351)
		H ₂ O	1.52	16	80.2	
		Me ₂ CO	2.19	13	83.8	
$C_9H_{16}O_2$	l - δ -Hydroxy- α -isopropyl- n -hexoic acid.....	EtOH	2.092		-13.54	(2045)
$C_{10}H_{12}O_3$	p -Methoxyhydratropic acid ($CH_3O.C_6H_4.CH(CH_3).COOH$).....	EtOH			-67.67	(179)
$C_{11}H_{14}O_3$	Ethyl atrolactate (l -ethyl α -hydroxy- α -phenylpropionate).....		1.097	13	-26.7	(1335)
$C_{19}H_{28}O_3$	l -Menthyl l -atrolactate.....	Me ₂ CO	1.98	9.5	-74.7	(1357)
		EtOH	1.27	10	-90.3	
		CHCl ₃	1.42	14	-102.7	
$C_{19}H_{28}O_3$	l -Menthyl dl -atrolactate.....	CS ₂	2.41	9	-55.9	(1357)
		C ₆ H ₆	2.12	15	-63.8	
		Me ₂ CO	2.04	14	-66.2	
		CHCl ₃	2.01	11	-69.5	
		EtOH	2.40	15	-72.0	
<i>IC₁ and ICB. Amino acids</i>						
$C_6H_{11}NO_2$	d - α -Aminoethylmethylacetic acid ($CH_3.CH_2.C(CH_3)(NH_2).COOH$).....	H ₂ O	8.52	20	11.0	(506)
		20% HCl	10	21	7.26	
$C_6H_{13}NO_2$	d -Isoleucine* (d - α -amino- β -methylvaleric acid).....	H ₂ O	3.08	20	11.29	(1265)
		20% HCl	4.64	20	40.61	
		H ₂ O	3.87	20	9.74	(409.5)
		20% HCl	4.57	20	36.80	
		N NaOH	3.28	20	11.09	
$C_6H_{13}NO_2$	Alloisoleucine.....	H ₂ O	2.39	20	-14.4	(410)
		20% HCl	4.70	20	-36.95	
	α -Alloisoleucine.....	20% HCl	4.71	20	-35.7	(412)
$C_7H_{13}NO_3$	d - α -Formylamino- β -methylvaleric acid.....	EtOH	9.04	20	28.26	(1265)
$C_8H_{14}ClNO_3$	Chloroacetyl- d -isoleucine.....	EtOH	4.88	20	25.0	(13)
$C_9H_{11}NO_2$	d - α -Amino- α -phenylpropionic acid.....	H ₂ O	2.02	18	70.0	(1336)
		N HCl	3.946	18	90.1	
	l - α -Amino- α -phenylpropionic acid.....	H ₂ O	1.82	20	-69.5	
		N HCl	2.74	18	-90.3	
$C_9H_{16}BrNO_3$	d - α -Bromopropionyl- d -isoleucine.....	EtOH	4.8	20	24.5	(13)
$C_{10}H_{11}NO_3$	d - α -Formylamino- α -phenylpropionic acid....	0.24N NaOH	4.626	15	130.1	(1336)
		EtOH	3.214	16	91.9	
$C_{12}H_{17}NO_4S$	Benzenesulfonyl- d -isoleucine.....	0.33N NaOH	7.37	20	-11.63	(1265); cf.
		N NaOH	7.62	20	-12.04	(409, 409.5)
$C_{12}H_{22}BrNO_3$	d - α -Bromoisohexoyl- d -isoleucine.....	AcOEt	4.57	20	48.97	(13)
$C_{13}H_{17}NO_3$	Benzoyl- d -isoleucine.....	N NaOH	7.43	20	26.36	(409.5)
$C_{13}H_{17}NO_3$	Benzoyl- d - α -amino- β -methylvaleric acid.....	0.5N NaOH	7.04	20	-26.03	(1265)
$C_{13}H_{18}N_2O_3$	d -Isoleucine phenylisocyanate.....	N NaOH	6.0	20	14.92	(409.5); cf. (409)
<i>IC₁ to IC_n. Dicarboxylic and tricarboxylic acids</i>						
$C_6H_{10}O_4$	Dimethylsuccinic acid†.....		5		-8	(2169.2)
$C_7H_{12}O_4$	d -Trimethylsuccinic acid.....	H ₂ O	5.016		4.83	(1554.5)
$C_7H_{10}O_4$	Pilopie acid†.....	H ₂ O	3.324	15	36.1	(1015.5)
	Sodium salt.....	Alk.	9.5	17	3.2	(1015.5)
$C_7H_{12}O_4$	Dimethylglutaric acid.....	H ₂ O	10		39.8	(1442)
$C_8H_{12}O_4$	Homopilopie acid§.....	H ₂ O	3.524	21	45.4	(1015.5)
	Sodium salt.....	H ₂ O	2.82	21	5.9	(1015.5)
$C_8H_{14}O_4$	d - α , α' -Dimethyladipic acid.....	EtOH	10	28	31.3	(1523)
$C_8H_{14}O_4$	α , γ -Dimethyladipic acid.....	EtOH	2.11		4.73	(811)
$C_9H_{16}O_4$	Dimethyl β -methyladipate.....		1.008	18	-3.82	(811)
$C_9H_{16}O_4$	α -Methyl- γ -ethyladipic acid.....	EtOH	1.36		13.52	(811)
$C_{10}H_{16}O_4$	α -Methyl- γ -allyladipic acid.....	EtOH	1.97		27.88	(811)
$C_{10}H_{18}O_4$	α -Methyl- γ -propyladipic acid.....	EtOH	1.96		16.97	(811)

* For polypeptides containing isoleucine, see p. 378.

† $CH_3.CH.COOH$. ‡ $CH.C_2H_5.CH.COOH$. § $CH.C_2H_5.CH.CH_2.COOH$.

IC₁ to IC_n. Dicarboxylic and tricarboxylic acids.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>c</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₀ H ₁₈ O ₆	<i>d</i> -α, δ-Dihydroxy-α-methyl-γ-isopropyladipic acid, sodium salt.....	H ₂ O	19		5.23	(850)
	<i>d</i> -α, δ-Dihydroxy-α-methyl-γ-isopropyladipic (p-acid), sodium salt.....	H ₂ O	17.5		4.25	(850)
C ₁₁ H ₂₀ O ₄	Diethyl β-methyladipate.....		1.04	18	2.40	(811)
C ₁₃ H ₂₄ O ₄	Dipropyl β-methyladipate.....		0.964	20	2.17	(811)
C ₁₅ H ₂₈ O ₄	Diisobutyl β-methyladipate.....		0.947	18	2.15	(811)
C ₁₆ H ₁₄ O ₄	<i>l</i> -Diphenylsuccinic acid.....	EtOH	2.33	13	-368.9	(2215)
C ₁₆ H ₁₄ O ₄	<i>d</i> -Diphenylsuccinic acid.....	EtOH	1.07	15	348	(1338)
C ₂₂ H ₃₈ O ₇	Agaric acid, potassium salt.....	H ₂ O	9.84	18	-9.82*	(2017)
	Sodium salt.....	H ₂ O	12.4	19	-8.84*	(2017)

ID. The Molecule Contains One Asymmetric Atom Attached to Four Other Carbon Atoms

ACIDS AND DERIVATIVES

Derivatives of acetic, malonic and camphoronic acids

C ₆ H ₁₅ NO ₃	<i>d</i> -Ethylisopropylmalonamic acid (NH ₂ .CO.C(C ₂ H ₅)(C ₃ H ₇).COOH).....	EtOH	10.1	21	14.55	(541)
C ₉ H ₁₀ BrClO ₄	α-Anhydrobromocamphoronyl chloride.....	CHCl ₃		20	-6.29	(727)
		H ₂ O	13.6	16	18.22	
		AcOH	9.12	16	7.97	
C ₉ H ₁₁ ClO ₄	α-Anhydrocamphoronyl chloride.....	CHCl ₃		20	6.25	(727)
	β-Anhydrocamphoronyl chloride.....	CHCl ₃		20	-4.21	
C ₉ H ₁₂ O ₅	Anhydrocamphoronic acid.....	CHCl ₃			5.56	(727)
C ₉ H ₁₃ NO ₂	<i>d</i> -Allylpropylecanoacetic acid.....	<i>N</i> NaOH	8.91	16	16.74	(493)
C ₉ H ₁₃ NO ₄	α-Anhydrocamphoronylimide.....	EtOH		20	-6.86	(727)
C ₉ H ₁₄ N ₂ O ₃	α-Camphoronamideimide†.....	MeOH		28	11.87‡	(727)
	β-Camphoronimideamide.....	Me ₂ CO		28	-13.73‡	(727)
C ₉ H ₁₄ O ₆	Camphoronic acid (HOOC.C(CH ₃) ₂ .C-(CH ₃)(COOH).CH ₂ .COOH).....	H ₂ O	10	19.5	-23.91	(58)
C ₉ H ₁₆ O ₄	Methyl hydrogen <i>d</i> -ethylisopropylmalonate.....	EtOH	9.96	22	1.84	(541)
		<i>N</i> KOH	14.1	23	-3.41	
C ₉ H ₁₇ NO ₃	Methyl <i>d</i> -ethylisopropylmalonamate.....	EtOH	9.87	20	-1.97	(541)
		EtOH	10.47	22	-2.02	
C ₁₁ H ₁₈ O ₆	Monoethyl dihydrogen camphoronate.....	EtOH		20	-30.21	(727)
C ₁₃ H ₂₂ O ₆	Diethyl camphoronate.....	EtOH		20	-9.91	(727)

Class II. ORGANIC SUBSTANCES, AT LEAST ONE ASYMMETRIC CARBON ATOM OF WHICH FORMS PART OF A RING

IIB₁ to B_n. The Molecule Contains Asymmetric Atoms Which Are Attached to Two Other Carbon Atoms

OXYGEN COMPOUNDS

MONOHYDRIC ALCOHOLS


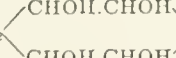
C₁₀H₁₂O, *ac*-Tetrahydro-2-naphthol and derivatives

C ₁₂ H ₁₄ O ₂	<i>l</i> - <i>ac</i> -Tetrahydro-β-naphthyl acetate.....		1.0891	20	-57.5	(1621)
				160	-53.2	
C ₁₃ H ₁₆ O ₂	<i>l</i> - <i>ac</i> -Tetrahydro-β-naphthyl propionate.....		1.0640	20	-57.0	(1621)
				160	-51.3	
C ₁₅ H ₂₀ O ₂	<i>d</i> - <i>ac</i> -Tetrahydro-β-naphthyl <i>n</i> -valerate.....		1.0281	20	40.0	(1621)
				160	42.5	
C ₁₇ H ₁₇ NO ₂	<i>l</i> - <i>ac</i> -Tetrahydro-β-naphthyl phenyl-carbamate (C ₁₀ H ₁₁ O.CO.NH.C ₆ H ₅).....	CHCl ₃	5.340		-26.31	(1621)
		C ₆ H ₆	5.067		-32.95	
C ₁₇ H ₂₄ O ₂	<i>l</i> - <i>ac</i> -Tetrahydro-β-naphthyl <i>n</i> -heptoate.....		1.0034	20	-42.9	(1621)
				160	-36.9	
C ₁₉ H ₂₈ O ₂	<i>d</i> - <i>ac</i> -Tetrahydro-β-naphthyl <i>n</i> -nonoate.....		0.9805	20	35.4	(1621)
				160	31.1	
C ₂₂ H ₃₄ O ₂	<i>d</i> - <i>ac</i> -Tetrahydro-β-naphthyl laurate.....		0.9645	20	32.7	(1621)
				160	28.1	

POLYHYDRIC ALCOHOLS

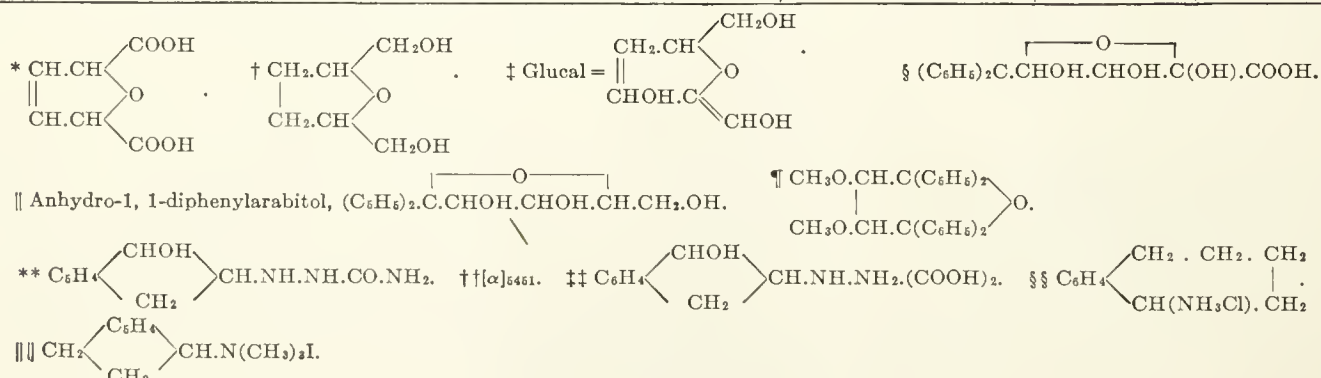
Quercitol and derivatives

C ₆ H ₁₂ O ₆	<i>l</i> -Quercitol§		4.04		-73.9	(1713)
C ₇ H ₁₄ O ₆	Pinitol (CH ₃ .O.C ₆ H ₆ (OH) ₅).....	H ₂ O	0.7	20	65.3	(747)
C ₇ H ₁₄ O ₆	<i>l</i> -Methylinositol (CH ₃ .O.C ₆ H ₆ (OH) ₅).....	H ₂ O	10		-80	(1637)
C ₁₆ H ₂₂ O ₁₀	Pentaacetyl- <i>l</i> -quercitol.....	CHCl ₃	2.70		-26.0	(1713)
C ₁₇ H ₂₄ O ₁₁	Pentaacetylpinitol.....			20	-9.67	(747)
C ₄₁ H ₃₂ O ₁₀	Pentabenzoyl- <i>l</i> -quercitol.....	CHCl ₃	2.83		-79.0	(1713)

* Calculated on weight of acid. † NH  C₆H₁₁.CO.NH₂. ‡ [α]_D461. § CH₂  CHO.

DERIVATIVES OF FURANE

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₆ H ₆ O ₅	<i>d</i> -β-Dihydrofurane-2, 5-dicarboxylic acid*...	H ₂ O	10.15		480.7	(911)
		H ₂ O	2.5		489.2	
		H ₂ O	0.157		519	
C ₆ H ₁₂ O ₃	Hydroglucal†.....	EtOH	9.913	20	16.31	(483)
C ₁₂ H ₁₆ O ₇	Triacetylglucal‡.....	EtOH	10.43	22	-15.76	(483)
C ₁₂ H ₁₈ O ₇	Triacetylhydroglucal.....	EtOH	9.645	17	33.93	(483)
		EtOH	9.352	17	35.55	
C ₁₇ H ₁₆ O ₆	1, 1-Diphenyl-2, 3, 4-trihydroxytetrahydrofurane-4-carboxylic acid§.....	EtOH	1.1869	14	199.5	(1550)
		EtOH	1.345	17	201.7	(1550)
C ₁₇ H ₁₈ O ₄	1, 1-Diphenyl-2, 3-dihydroxy-4-hydroxy-methyltetrahydrofurane 	H ₂ O	0.4075	20	85.6	(1550)
C ₃₀ H ₂₈ O ₃	3, 4-Dimethoxy-2, 2, 5, 5-tetraphenyl-tetrahydrofurane¶.....	C ₆ H ₆	8.272	20	-115.7	(1747)
CARBOXYLIC ACIDS						
<i>Di- and tetrahydronaphthoic acids</i>						
C ₁₁ H ₁₀ O ₂	Δ ²⁽³⁾ -Dihydro-1-naphthoic acid.....	CHCl ₃	1.65		212.9	(1632)
		C ₆ H ₆	23.94		178.0	
	Sodium salt.....	H ₂ O	1.390		191.1	(1632)
C ₁₁ H ₁₀ O ₂	Δ ³ -Dihydro-2-naphthoic acid.....	CHCl ₃	1.802		158.7	(1636)
		C ₆ H ₆	1.597		182.2	
	Sodium salt.....	H ₂ O	1.624		157.6	(1636)
C ₁₁ H ₁₂ O ₂	1, 2, 3, 4-Tetrahydro-1-naphthoic acid.....	CHCl ₃	1.630		-15.9	(1633)
		C ₆ H ₆	1.750		-52.3	
	Sodium salt.....	H ₂ O			-10.6	
C ₁₁ H ₁₂ O ₂	1, 2, 3, 4-Tetrahydro-2-naphthoic acid.....	CHCl ₃	1.399		-51.8	(1634)
		C ₆ H ₆	1.382		-50.0	
	Sodium salt.....	H ₂ O	1.373		-41.88	(1634)
<i>Other carboxylic acids</i>						
C ₁₁ H ₁₂ O ₃	Acetone- <i>l</i> -mandelic acid (C ₆ H ₅ .CH<O-C(CH ₃) ₂ CO.O).....	AcOEt	4.30	18	-94.78	(2187)
AMINES						
MONOBASIC AMINES: NITROGEN IN SIDE CHAIN						
<i>Tetrahydronaphthylamine and derivatives</i>						
C ₁₀ H ₁₄ ClN	<i>d</i> - <i>ac</i> -Tetrahydro-β-naphthylamine hydrochloride.....	H ₂ O	1.45	12	71.9	(1667)
C ₁₂ H ₁₅ NO	Acetyl- <i>d</i> - <i>ac</i> -tetrahydro-β-naphthylamine....	C ₆ H ₆	0.447	16.5	36.9	(1667)
C ₁₇ H ₁₇ N	Benzylidene- <i>d</i> - <i>ac</i> -tetrahydro-β-naphthylamine.....	EtOH	1.46	18.5	27.6	(1667)
C ₁₇ N ₁₇ NO	Benzoyl- <i>d</i> - <i>ac</i> -tetrahydro-β-naphthylamine...	Me ₂ CO	0.095	19	58	(1667)
C ₁₇ H ₁₇ NO ₂	<i>l</i> - <i>ac</i> -Tetrahydro-2-naphthyl phenylcarbamate	C ₆ H ₆	5.067		-32.95	(1621)
		CHCl ₃	5.340		-26.31	
<i>Other monobasic amines</i>						
C ₁₀ H ₁₃ N ₃ O ₂	<i>l</i> -1-Hydroxy-2-semicarbazinohydrindene**...	EtOH	0.510	20	-14.7††	(1592)
C ₁₁ H ₁₄ N ₂ O ₅	<i>l</i> -1-Hydroxy-2-hydrazinohydrindeneoxalate‡‡	H ₂ O	0.375	20	14.0	(1592)
C ₁₁ H ₁₆ ClN	Pheno-α-aminocycloheptane hydrochloride§§	H ₂ O	1.09		-24	(1078)
C ₁₂ H ₁₈ IN	<i>d</i> - <i>N</i> -Trimethylhyrindonium iodide 	H ₂ O	1.58		22.2	(1071)
MONOBASIC AMINES: NITROGEN IN RING						
<i>Derivatives of piperidine including coniine</i>						
C ₆ H ₁₃ N	<i>d</i> -2-Methylpiperidine (2-pipecoline).....		0.860	0	37.29	(1153)



Derivatives of piperidine (including coniine).—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>c</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₇ H ₁₆ N	<i>d</i> -2-Ethylpiperidine.....		0.8680 ₄		17.08	(665)
C ₈ H ₁₆ N	Iso-2-allylpiperidine $\left(\text{CH}_2 \begin{array}{l} \text{CH}_2.\text{CH}.\text{C}_3\text{H}_5 \\ \text{CH}_2.\text{CH}_2 \end{array} \text{NH} \right)$		0.8670 ₄ ¹⁵	15	−29.02	(1269)
C ₈ H ₁₇ N	<i>d</i> - <i>N</i> -Ethyl-2-pipecoline.....		0.8361 ¹⁸		101.06	(914.8)
	<i>l</i> - <i>N</i> -Ethyl-2-pipecoline.....		0.8364 ¹⁸		−98.3	(1887)
C ₈ H ₁₇ N	<i>d</i> -3-Methylpiperidine.....				3.98	
C ₈ H ₁₇ N	<i>d</i> - <i>N</i> -Ethyl-3-pipecoline.....		0.8095 ¹⁷		−3.2	(1887)
C ₈ H ₁₇ N	<i>d</i> - and <i>l</i> -β-Propylpiperidine.....		0.8517	16	±6.39	(746)
C ₈ H ₁₇ N	Coniine; cf. (1147, 1151, 2207, 2228).....		0.873	15	15.6	(1869)
	Coniine.....	CHCl ₃	4	27	8.00	(901)
		CHCl ₃	1	27	9.00	
	Isoconiine (synthetic coniine).....		0.8458	18.5	17.85	(1155)
C ₈ H ₁₇ NO	Conhydrine (β-hydroxyconiine).....	EtOH	10		10	(1893)
C ₈ H ₁₈ N ₂	Aminoconiine.....		0.9942 ₁₆ ¹⁵		−2.33	(1268)
C ₉ H ₁₉ N	<i>N</i> -Methylconiine.....		0.8318 ²⁴		81.33	(2207)
		EtOH	13.6	24	35.66	(228)
C ₉ H ₁₉ N	<i>d</i> - <i>N</i> -Propyl-2-pipecoline.....		0.8296 ²⁰		100.34	(914.8)
C ₁₀ H ₁₉ NO	Acetylconiine.....		0.9616	16	34.2	(1149)
C ₁₀ H ₂₁ N	<i>N</i> -Ethylconiine.....		0.8398 ²¹		75.62	(915)
C ₁₀ H ₂₁ NO	1-Ethylconhydrine.....		0.9345 ₄ ²⁰		−45.2	(1893)
C ₁₁ H ₂₃ N	<i>l</i> - <i>N</i> -Isoamyl-2-pipecoline.....		0.8310 ¹⁹		−88.86	(914.8)
C ₁₁ H ₂₃ N	<i>N</i> -Propylconiine.....		0.8423 ¹⁸		76.21	(915)
C ₁₁ H ₂₃ NO	1-Propylconhydrine.....		0.9172 ₄ ²⁰		−50.1	(1893)
C ₁₂ H ₁₇ N	<i>d</i> -2-Phenyl-6-methylpiperidine.....		0.9497 ₂₀ ²⁰		44.81	(1892)
	<i>d</i> -2-Isophenyl-6-methylpiperidine.....				0.92	
C ₁₂ H ₂₅ N	<i>N</i> -Butylconiine.....		0.8393 ₄ ²⁰		72.6	(1885)
C ₁₃ H ₂₇ N	<i>N</i> -Isoamylconiine.....		0.8352 ^{23.5}		75.14	(915)
C ₁₃ H ₂₇ NO	1-Isoamylconhydrine.....		0.9087		−45.1	(1893)
C ₁₅ H ₂₁ NO	Benzoylconiine.....		1.0623 ¹⁶	16	29.1	(1149)
C ₁₅ H ₂₃ N	<i>N</i> -Benzylconiine (C ₈ H ₁₆ N.CH ₂ .C ₆ H ₅).....		0.9461 ₄ ²⁰	20	72.9	(1884)
C ₁₇ H ₂₃ NO ₂	Coniine phenylpropionate.....	CHCl ₃	4	21	−7.12	(901)
		H ₂ O	4	24	1.00	
C ₁₇ H ₂₆ NO ₂	Coniine cinnamate.....	CHCl ₃	4	22	−7.50	(901)
		CHCl ₃	1	22	8.50	
		H ₂ O	4	24	1.75	
C ₁₇ H ₂₇ NO ₂	Coniine β-phenylpropionate.....	CHCl ₃	4	27	−1.87	(901)
		CHCl ₃	1	27	2.00	
		H ₂ O	4	24	2.50	
C ₂₀ H ₃₄ INO	α-Benzylisoamylconhydrinium iodide.....	EtOH	5	20	−40	(1893)
	β-Benzylisoamylconhydrinium iodide.....	EtOH	5	20	−50	(1893)
C ₂₀ H ₃₆ N ₂ O ₄	Diconiine acetylenedicarboxylate.....	CHCl ₃	4	22	3.37	(901)
		H ₂ O	4	24	1.00	
C ₂₀ H ₃₈ N ₂ O ₄	Diconiine maleate.....	CHCl ₃	4	18	4.38	(901)
		H ₂ O	4	24	2.00	
C ₂₀ H ₃₈ N ₂ O ₄	Diconiine fumarate.....	CHCl ₃	4	22	4.00	(901)
		H ₂ O	4	24	1.75	
C ₂₀ H ₄₀ N ₂ O ₄	Diconiine succinate.....	CHCl ₃	4	22	5.12	(901)
		H ₂ O	4	24	1.50	

Tetrahydroquinaldine and derivatives

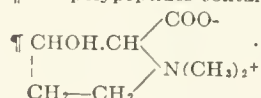
C ₉ H ₁₁ N	<i>l</i> -Dihydro-α-methylindole					
	$\left(\text{C}_6\text{H}_4 \begin{array}{l} \text{CH}_2 \\ \text{NH} \end{array} \text{CH}.\text{CH}_3 \right)$	EtOH	3.80		7.22	(1661)
		Et ₂ O	5.24		−13.53	
		C ₆ H ₆	3.47		8.25	
C ₉ H ₁₂ ClN	<i>l</i> -Dihydro-α-methylindole hydrochloride.....	H ₂ O	4.15		1.68	(1661)
C ₁₀ H ₁₃ N	<i>l</i> -Tetrahydroquinaldine, tetrahydro-α-methylquinoline, $\left(\text{C}_6\text{H}_4 \begin{array}{l} \text{CH}_2.\text{CH}_2 \\ \\ \text{NH}.\text{CH}.\text{CH}_3 \end{array} \right)$		1.0236	20	−58.12	(1671, 1672)
		Et ₂ O	2.51	21.0	−50.8	
		Me ₂ CO	2.54	19.5	−63.3	
	In methyltetrahydroquinoline.....		18.77	19.0	−63.6	

Tetrahydroquinaldine and derivatives.—(Continued)

Formula	Name	Solvent	d , C or %	t , °C	$[\alpha]_D$	Lit.
$C_{10}H_{13}N$	<i>l</i> -Tetrahydroquinaldine.—(Cont'd).....		6.70	24.2	−58.9	
	In tetrahydroquinoline.....	EtOH	2.56	21.5	−64.0	
		MeOH	2.53	19.5	−75.1	
		$CHCl_3$	2.59	21.5	−85.3	
		C_6H_6	2.56	21.0	−88.6	
		CCl_4	2.53	21.5	−97.6	
		AcOH	2.61	21.0	−117.9	
$C_{11}H_{13}NO$	<i>l</i> -Acetyldihydro- α -methylindole.....	$C_6H_{11}N$	8.25	23.8	−45.9	
$C_{11}H_{15}N$	<i>l</i> -Tetrahydro- <i>p</i> -toluquinaldine.....	EtOH	1.36		−61.9	(1661)
		C_6H_6	1.98	21	−80.9	(1688)
		Me_2CO	2.14	18	−59.1	
		EtOH	2.12	18	−67.6	
		$CHCl_3$	1.99	18	−78.8	
$C_{12}H_{17}N$	<i>d</i> -Tetrahydro- <i>p</i> -toluquinaldine.....	H_2O	2.03	18	70.3	
		C_6H_6	1.94	19	80.7	
	1-Ethyl-2-methyltetrahydroquinoline.....		0.9942 ²⁰	20	12.1	(1893)
$C_{14}H_{15}N$	<i>d</i> -Tetrahydro- β -naphthoquinaldine.....	EtOH (abs.)	0.670	29.5	109.0	(719)
		C_6H_6	0.499	29.5	157.0	
$C_{16}H_{15}NO$	<i>l</i> -Tetrahydro- β -naphthoquinaldine.....	EtOH (abs.)	0.647	29.5	−108.5	
	<i>l</i> -Benzoyldihydro- α -methylindole.....	EtOH	1.64		−37.1	(1661)
$C_{18}H_{19}NO$	Benzoyl- <i>l</i> -tetrahydro- <i>p</i> -toluquinaldine.....	EtOH	2.05	18	229	(1688)
$C_{21}H_{19}NO$	Benzoyl derivative of <i>l</i> -tetrahydro- β -naphthoquinaldine (dextro base).....	C_6H_6				
	(levo base).....	EtOH (abs.)	0.362	29.5	−587.0	(719)
		EtOH (abs.)	0.351	29.5	587.6	
POLYBASIC AMINES						
<i>Nicotine and derivatives</i>						
$C_{10}H_{14}N_2$	Nicotine $\left(\begin{array}{c} CH_2.CH_2 \\ \\ CH_2.N.CH_3 \end{array} \right) CH.C \begin{array}{c} CH.CH \\ CH:N \end{array} CH$	H_2O	4.795		−77.9	(268)
		50% EtOH	4.368		−104.2	
		EtOH	21	20	−30	(385); cf. (2200)
	($[\alpha]_D$ calculated on C at 20° C).....	EtOH	21	−50	−28.7	
	($[\alpha]_D$ calculated on C at 20° C).....	EtOH	21	−70	−27.3	
	($[\alpha]_D$ calculated on C at 20° C).....	EtOH	21	−90	−25.3	
	($[\alpha]_D$ calculated on C at 20° C).....	EtOH	21	−120	−22	
$C_{14}H_{20}N_2O_6$	<i>d</i> -Nicotine <i>l</i> -tartrate.....	H_2O	7.96	15	−25.58	(1645); cf. (1639)
	<i>l</i> -Nicotine <i>d</i> -tartrate.....	H_2O	8.57	15	27.16	
<i>Other polybasic amines</i>						
$C_{13}H_{16}N_2O_6$	Tetrahydroxybutyl- <i>N</i> -phenylhydantoin*.....	H_2O	1.95		93.2	(1498)
$C_{18}H_{36}N_2$	Ethylene- <i>bis-d</i> -coniine†.....	MeOH	1.825		81.09	(2152)
$C_{20}H_{18}N_2$	<i>l</i> -2, 3-Diphenyl-1, 2, 3, 4-tetrahydro-quinoxaline‡.....	EtOH	0.799	20	−40.8	(109)
	<i>l</i> -2, 3-Diphenyl-2, 3-dihydro-1, 3, 4-naphthaisotriazine <i>d</i> - α -bromocamphor- π -sulfonate§	Me_2CO	2.3	20	23.8	(1689)
		EtOH	2.3	20	25.7	
		$CHCl_3$	2.3	20	−1.3	
AMINO ACIDS						
<i>Proline and derivatives</i>						
$C_5H_9NO_2$	<i>l</i> -Proline <i>l</i> -pyrrolidine-2-carboxylic acid, $\begin{array}{c} CH_2.NH \\ \\ CH_2.CH_2 \end{array} CH.COOH$	H_2O	7.93	20	−77.40	(469)
		20% HCl	7.68	20	−46.53	
		0.5 <i>N</i> NaOH	5.73	20	−83.48	
	<i>l</i> -Proline (synthetic).....	H_2O	6.46	20	−80.9	(561.2)
		0.6 <i>N</i> KOH	2.35	20	−93.0	
$C_7H_{13}NO_3$	<i>d</i> -Proline (synthetic).....	H_2O	3.865	20	+81.5	(561.2)
	Betonicine¶.....	H_2O	4.88	15	−36.60	

* $H(CHOH)_4.CH \begin{array}{c} NH.CO \\ | \\ CO.N.C_6H_5 \end{array}$, from glucosamine. † $C_5H_{15}N.CH_2.CH_2.N.C_5H_9$. ‡ $C_5H_9 \begin{array}{c} NH.CH.C_6H_5 \\ | \\ NH.CH.C_6H_5 \end{array}$. § Salt of $C_{10}H_6 \begin{array}{c} N.CH.C_6H_5 \\ | \\ N.N.C_6H_5 \end{array}$.

|| For polypeptides containing proline, see p. 377, 378.



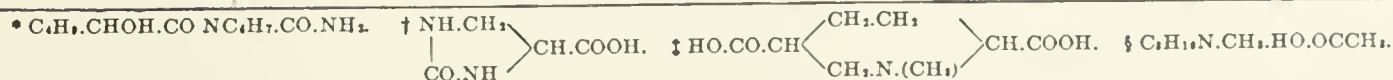
Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₇ H ₁₄ ClNO ₃	Betonicine hydrochloride.....	H ₂ O	8.58	15	-24.79	
C ₇ H ₁₃ NO ₃	Turicine (stereoisomer of betonicine).....	H ₂ O	12.05		36.26	(1139)
C ₇ H ₁₄ ClNO ₃	Turicine hydrochloride.....	H ₂ O	7.18		24.65	(1139)
C ₁₁ H ₁₇ NO ₂	α-Hydroxyisohexoyl- <i>l</i> -prolinolactone.....	AcOH	2.92	20	-166.8	(540)
C ₁₁ H ₂₀ N ₂ O ₃	α-Hydroxyisohexoyl- <i>l</i> -prolinamide*.....	H ₂ O	2.69	20	-78.6	(540)
C ₁₂ H ₁₂ N ₂ O ₆	<i>d-m</i> -Nitrobenzoylproline.....	<i>N</i> NaOH	3.95	20	+120.0	(561.2)
<i>Other cyclic amino acids</i>						
C ₄ H ₆ N ₂ O ₃	Glyoxalid-2-on-5-carboxylic acid†.....	H ₂ O	2.1	18	-16.5	(1040)
C ₈ H ₁₃ NO ₄	<i>l</i> -Tropinic acid†.....	H ₂ O	6.5	20	-15.2	(699)
C ₉ H ₁₄ O	<i>d</i> -3-Acetyl-1-methyl-Δ ² -cyclohexene.....		0.9413 ₂₂ ²²		100.4	(841)
C ₁₁ H ₂₁ NO ₂	Methylconiinyl <i>N</i> -acetate§.....		0.9726	20	62.1	(1884)
C ₂₂ H ₂₃ NO ₇	<i>d</i> -Narcotine.....	CHCl ₃	2.606		199.9	(1602); <i>cf.</i> (725, 1601.8)
C ₃₂ H ₃₈ BrNO ₁₁ S	<i>l</i> -Narcotine.....	CHCl ₃	3.356		-199.3	
	<i>dl</i> -Narcotine <i>d</i> -bromocamphorsulfonate.....	CHCl ₃	2.155		20.2	(1602)
	<i>l</i> -Narcotine <i>d</i> -bromocamphorsulfonate.....	CHCl ₃	2.248		100.7	
	<i>d</i> -Narcotine <i>l</i> -bromocamphorsulfonate.....	CHCl ₃	3.319		-97.2	
	<i>l</i> -Narcotine <i>l</i> -bromocamphorsulfonate.....	CHCl ₃	2.662		29.01	

HYDROCARBONS

Cyclic hydrocarbons not related directly to menthane

C ₆ H ₁₀	Methyl-Δ ² -cyclopentene.....		0.7663	18	27.22	(2232)
C ₇ H ₁₂	1-Methyl-Δ ²⁽³⁾ -cyclohexene.....		0.7937 ²⁷ ₄		81.47	(2232)
C ₇ H ₁₀ Br ₂	1-Methyl-Δ ^{2,4} -cyclohexadiene dibromide....		0.8274 ²⁰ ₄		36.42	(2234)
C ₈ H ₁₂	1, 3-Dimethyl-Δ ^{2,4} -cyclohexadiene		0.8225 ²⁰ ₄		27.38	(2235)
C ₈ H ₁₄	Laurolene (Δ ¹ -1, 2, 3-trimethylcyclopentene)		0.8008 ^{17.6}		23.8	(2026)
			0.8030 ¹⁵ ₄	23	22.8	(1517)
			0.7991 ²⁰ ₂₀	26.2	28.15	(1518)
C ₉ H ₁₄	1, 3-Dimethyl-Δ ²⁽³⁾ -cyclohexene.....		0.8015 ²² ₄		95	(2237.5); cf. (2232)
C ₉ H ₁₄	<i>l</i> -1-Methyl-3-methylenecyclohexane	EtOH	14.4	15	-30.22	(2117)
C ₉ H ₁₆	1-Methyl-3-ethyl-Δ ²⁽³⁾ -cyclohexene.....		0.8087 ²⁵ ₄		56.8	(2237.5); cf. (2232)
C ₉ H ₁₆	<i>l</i> -1-Methyl-3-ethylidenecyclohexane.....		0.8135 ¹⁹ ₁₉		-50	(841)
C ₉ H ₁₆	1-Methylcyclohexylidene-3-ethane.....		0.8154 ¹⁹ ₄		56.63	(2236)
C ₁₀ H ₁₆	1-Methyl-3-propylidenecyclohexane.....		0.814	19	-42.3	(2120)
C ₁₁ H ₁₈	<i>d</i> -1-Methyl-3-dimethylvinyl-Δ ³ -cyclohexene.		0.846 ¹⁵ ₄		68.8	(837.5)
			0.8445 ¹⁵ ₄		63.9	
	<i>d</i> -1-Methyl-3-dimethylvinyl-Δ ² -cyclohexene..		0.8531 ¹⁵ ₄		54.8	
C ₁₁ H ₂₀	1, 3-Dimethyl-4-isopropyl-Δ ²⁽³⁾ -cyclohexene.		0.8192 ²⁶ ₄		88.53	(2237.5); cf. (2232)
C ₁₆ H ₂₂	1-Phenyl-5-methyl-2-isopropenylcyclohexane		0.9462 ^{15.7} ₄		17	(1093)
C ₁₆ H ₂₂	1-Methyl-3-phenyl-4-isopropylcyclohexene.		0.9621 ²⁰		13.9	(1481)
C ₁₆ H ₂₈	1-Methyl-3-cyclohexyl-4-isopropyl- cyclohexene.....		0.9198 ¹⁴		6.2	(1481)
C ₁₈ H ₂₄	Phenylbutadienyltrimethylcyclopentane.....	C ₆ H ₆	9.91	20	3.86	(1827)

$C_{10}H_{16}$	$d-\Delta^{5,8(9)}$ -Menthadiene.....	AcOEt	4.562	17	29.6	(1600)
$C_{10}H_{16}$	$d-\Delta^{2,8(9)}$ - <i>m</i> -Menthadiene.....		0.864 ¹⁷ ₁₇	17	64.0	(841)
	$\Delta^{3,8(9)}$ -Menthadiene.....		0.8420 ²⁰		17.6	(1931)
	$d-\Delta^{3,8(9)}$ - <i>m</i> -Menthadiene.....	AcOEt	3.558		17.5	(1312)
	<i>l</i> - $\Delta^{3,8(9)}$ - <i>m</i> -Menthadiene.....	AcOEt	4.059		-12.9	(1312)
	$d-\Delta^{3,8(9)}$ - <i>p</i> -Menthadiene.....	AcOEt	4.272		>100.0	(288)
		C_6H_6		18	98.2	(1048)



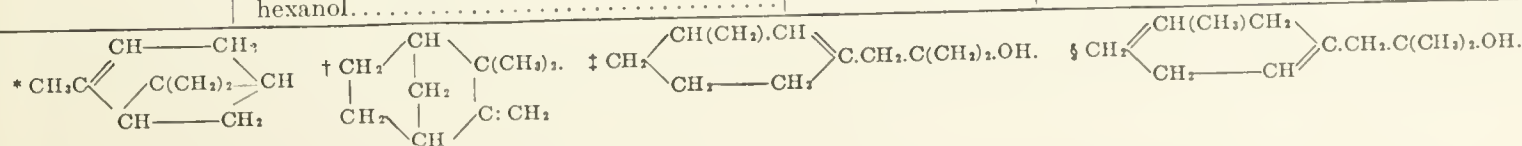
Menthane and hydrocarbon derivatives, excluding natural terpenes.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₀ H ₁₈	<i>d</i> -Menthene; <i>cf.</i> (296, 1947, 1966).....			20	115.64	(306); <i>cf.</i> (114)
	<i>l</i> -Menthene.....		0.816 ₂₀ ²⁰	20	−38	
C ₁₀ H ₁₈ ClNO	Carvomenthene nitrosochloride.....	Et ₂ O	5.59		724*	(2063.5)
	(λ = 5780).....	Et ₂ O	5.59		344	
C ₁₀ H ₂₀	<i>m</i> -Menthane†.....		0.8116	23	1.6	(1852)
C ₁₁ H ₁₆	2-Methyl-Δ ^{2,6,8,(9)} -menthatriene.....		0.8724	21.1	69.12	(1089)
C ₁₁ H ₁₆	2-Methylmenthatriene.....		0.8776 ₄ ¹⁵	21	69.12	(1090)
C ₁₁ H ₁₆	Methylmenthatriene.....		0.8747 ²⁰	20	103.49	(1825)
C ₁₁ H ₁₈	3-Methyl-Δ ^{2,8,(9)} -menthadiene.....		0.8400	20	46.27	(1824)
C ₁₁ H ₁₈	3-Methyl-Δ ^{1,4,(8)} -menthadiene.....		0.840 ²⁰	20	−96.89	(1826)
C ₁₁ H ₁₈	Methylmenthadiene.....		0.8576 ²⁰	20	−55.44	(1825)
C ₁₂ H ₁₈	2-Ethylmenthatriene.....		0.8880 ₄ ¹⁵	18	86.19	(1090)
C ₁₃ H ₂₀	2-Propyl-Δ ^{2,5,8,(9)} -menthatriene.....		0.8804 ₄ ¹⁵	22	86.20	(1090)
C ₁₆ H ₁₈	2-Phenyl-Δ ^{2,6,8,(9)} -menthatriene.....		0.9882 ₄ ^{13.8}	13.8	110.2	(1089)
<i>Limonene and derivatives</i>						
C ₁₀ H ₁₆	<i>d</i> -Limonene (Δ ^{1,8,9} - <i>p</i> -menthadiene, $\left(\text{CH}_3.\text{C} \begin{array}{l} \text{CH}.\text{CH}_2 \\ \text{CH}_2.\text{CH}_2 \end{array} \right) \text{CH}.\text{C} \begin{array}{l} \text{CH}_3 \\ \text{CH}_2 \end{array}$)	MeOH	9.27	20	124.77	(306)
		MeOH	0.36	20	109.3	(2100)
		EtOH	10.59	20	112.00	
		EtOH	0.449	20	111.4	
		Me ₂ CO	10.36	20	112.5	
		Me ₂ CO	0.523	20	115.0	
		AeOEt	9.21	20	112.9	
		AeOEt	0.47	20	114.8	
		CCl ₄	10.10	20	112.6	
		CCl ₄	0.427	20	113.0	
		C ₆ H ₆	11.14	20	122.1	
		C ₆ H ₆	0.523	20	117.6	
	<i>l</i> -Limonene.....				−113.8	(596); <i>cf.</i> (2109, 2128)
	<i>d</i> -Limonene.....				120.6	
C ₁₀ H ₁₆ Br ₄	<i>l</i> -Limonene tetrabromide.....	CHCl ₃	22.24		−74.6	(229)
C ₁₀ H ₁₆ ClNO	<i>d</i> -Limonene-α-nitrosochloride.....	CHCl ₃	21.13	17	304.0	(2107, 2128); <i>cf.</i> (1324.2, 2109)
C ₁₀ H ₁₆ ClNO	<i>d</i> -Limonene-β-nitrosochloride.....	CHCl ₃	5.34	10.5	240.3	
C ₁₀ H ₁₆ N ₄ O	<i>d</i> -Limonene nitrosoazide.....	CHCl ₃	1.188		6.5	(596); <i>cf.</i> (596.5)
C ₁₀ H ₁₈	Dihydrolimonene.....		(λ = 5780)		118	(2062)
			(λ = 4360)		234	
C ₁₀ H ₁₈ Br ₂	Dihydrolimonene dibromide.....		(λ = 5780)		49	(2062)
			(λ = 4360)		100	
C ₁₀ H ₁₈ ClNO	Dihydrolimonene nitrosochloride.....		(λ = 5780)		344	(2062)
			(λ = 4360)		724	
C ₁₁ H ₁₈	2-Methylimonene.....				−7.99	(1825)
			0.8598 ²⁰		−25.33	
C ₁₁ H ₁₈ N ₂ O ₂	<i>d</i> -Limonene α-nitrosoearboxamide.....	CHCl ₃	2.02	17	174.9	(1179)
C ₁₇ H ₂₁ N ₅ O ₂	<i>l</i> -Limonene nitrosoazidephenylearbamyloxime	CHCl ₃	1.187		−120.8	(596)
	<i>d</i> -Limonene nitrosoazidephenylearbamyloxime	CHCl ₃	1.108		118.8	
C ₁₈ H ₂₀ N ₂ O ₂	Benzoyl- <i>d</i> -limonene α-nitrosoeyanide.....	CHCl ₃	2.04	15	127.2	(1179)
	Benzoyl- <i>d</i> -limonene β-nitrosoeyanide.....	CHCl ₃	2.02	18	−108.2	
C ₁₈ H ₂₂ N ₂ O ₃	Benzoyl- <i>d</i> -limonene α-nitrosoearboxamide...	CHCl ₃	1.67	19	241.7	(1179)
<i>Sylvestrene, phellandrene and other monocyclic terpenes</i>						
C ₁₀ H ₁₄	<i>l</i> -Verbenene.....		0.8822 ²⁰	19	−84.9	(154)
C ₁₀ H ₁₆	Sylvestrene; <i>cf.</i> (65, 1143, 2031, 2128).....		0.8625 ₀ ²¹	21	15.6	(1852)
	<i>d</i> -Sylvestrene.....	AeOEt	5		67.5	(840)
	<i>l</i> -Sylvestrene.....	AeOEt	5		−68.2	
C ₁₀ H ₁₆	<i>d</i> -Phellandrene.....		0.8558	10	17.64	(1607.5)

* [α]₄₃₅₉. † CH₂ $\begin{array}{l} \text{CH}(\text{CH}_3).\text{CH}_2 \\ \text{CH}_2-\text{CH}_2 \end{array}$ CH.CH(CH₃)₂.

Sylvestrene, phellandrene and other monocyclic terpenes.—(Continued)

Formula	Name	Solvent	d, C or %	t, °C	[α] _D	Lit.
C ₁₀ H ₁₈ Cl ₂	<i>d</i> -Sylvestrene dihydrochloride.....	AcOEt	5		22.5	(840)
	<i>l</i> -Sylvestrene dihydrochloride.....	AcOEt	5		-21.8	
DICYCLIC HYDROCARBONS						
<i>Pinene and pinolene</i>						
C ₁₀ H ₁₆	β-Pinene.....	Et ₂ O	0.8630 ²¹	20	15.93	(2118)
			13.64	20	12.76	
	<i>l</i> -Pinene* } <i>cf.</i> (65, 83, 117, 364, 566, 567,			20	-40.0	(306); <i>cf.</i>
	<i>d</i> -Pinene* } 1776, 1783, 2128, 2209).....		0.8635 ¹⁴	14	39.4	(83)
C ₁₀ H ₁₆	Pinolene.....		0.8599 ²⁰	20	1.63	(59)
C ₁₀ H ₁₆ O ₃	Pinene ozonide.....	CHCl ₃	52.5	20	11.67	(832)
C ₁₀ H ₁₇ Br	<i>d</i> -Pinene hydrobromide.....	EtOH	8	21	31.31	(2042)
C ₁₀ H ₁₇ Cl	<i>d</i> -Pinene hydrochloride.....	EtOH	8	17	33.19	(2042)
C ₁₀ H ₁₇ Cl	Pinolene hydrochloride.....	C ₆ H ₆	18.9	20	9.78	(59)
C ₁₀ H ₁₈	Isopinolene hydrochloride.....	C ₆ H ₆	18.9	20	9.18	
	Pinane (from pinenes by various methods)..		0.8519	17.5	-16.1	(1256.5)
			0.8566	20	23.08	
			0.8562	20	-18.9	
<i>Camphene and bornylene</i>						
C ₁₀ H ₁₆ NO ₂	<i>l</i> -Nitrocamphene.....	C ₆ H ₆	20	20	-146.4	(1256)
C ₁₀ H ₁₆	<i>d</i> -Camphene;† <i>cf.</i> (120, 125.5, 171, 735, 1034, 1158, 1391, 1447, 1779, 1980).....	EtOH	10	25	83.5	(2042)
		C ₆ H ₆	20	28	84.05	
		Me ₂ CO	20	27	83.8	
		PhMe	17.87	20	-95.56	(306)
C ₁₀ H ₁₆	<i>l</i> -Camphene.....	C ₆ H ₆	20.2	20	17.95	(60)
	Camphene (American).....	C ₆ H ₆	50	20	74.55	
	From bornyl toluene- <i>p</i> -sulfonate.....	EtOH	2.064	20	38.8	(451)
		EtOH	2.064	20	38.9	
	From Siberian pinewood oil.....	Et ₂ O	11.36	18	-84.9	(2118)
	From bornylamine.....	Et ₂ O	9.67	17	103.89	
C ₁₀ H ₁₈	Isocamphane (liquid); <i>cf.</i> (84, 565, 1143, 1161, 1608, 1778).....	MeOH	10	19	1.15	(1255)
C ₁₆ H ₂₀	β-Phenylcamphene.....		0.9736 ¹⁸		7.25	(802)
C ₂₀ H ₃₄	<i>d</i> -Hydrodicamphene.....	C ₆ H ₆	20		28.70	(896)
<i>Fenchene and other dicyclic terpenes</i>						
C ₁₀ H ₁₆	Fenchene (from fenchyl chloride).....		0.8631 ²¹	20	-9.65	(1130); <i>cf.</i>
						(1124)
C ₁₀ H ₁₆	<i>D</i> - <i>l</i> -Fenchene.....		0.869 ¹⁰	18	-37.1	(2130)
C ₁₀ H ₁₆ Br ₂	<i>D</i> - <i>l</i> -Fenchene dibromide.....	AcOEt	3.56	11	42.83	(2130)
C ₁₁ H ₁₈	Methylfenchene.....		0.8638 ²⁷		19.68	(2237.5)
SESQUITERPENES						
C ₁₅ H ₂₄	Isozingiberene (bieyclic).....		0.9118	20	-51.60	(1926)
C ₁₅ H ₂₄	Metazingiberene.....		0.8927 ²⁰	20	6.5	(1926)
C ₁₅ H ₂₄	Selinene (from dihydrochloride).....		0.9190 ²⁰		61.36	(1932)
C ₁₅ H ₂₄ N ₂ O ₃	β-Caryophyllene nitrosite.....	C ₆ H ₆	0.4729		1625.0	(381)
		ligroin	0.01713		1661.0	
C ₁₅ H ₂₆ ClN ₂ O ₄	β-Hydrochlorocaryophyllene nitrosite.....	C ₆ H ₆	0.5266	21	930.4	(381)
C ₁₆ H ₂₆	Dihydrozingiberene.....		0.8557 ²⁰	20	-37	(1926)
C ₁₆ H ₂₈	Tetrahydroisozingiberene (bicyclic).....		0.8822	20	4.60	(1926)
C ₁₆ H ₂₈	Tetrahydroselinene.....		0.8889 ²⁰		1.12	(1932)
			0.8881 ²⁰		7	
C ₁₆ H ₃₀	Hexahydrozingiberene.....		0.8264	20	-10.20	(1926)
C ₃₀ H ₄₈	Dizingiberene.....		0.9287	20	-5	(1926)
ALCOHOLS						
MONOHYDRIC ALCOHOLS						
<i>Alcohols not derived directly from terpenes</i>						
C ₉ H ₁₈ O	1-Methyl-3-ethylcyclohexan-3-ol.....		0.8995 ²¹		1.48	(2231)
C ₁₁ H ₂₀ O	<i>d</i> -1-Methyl-3-isobutanol-Δ ³ -cyclohexene†...	Me ₂ CO			49.5	(837.5)
	<i>d</i> -1-Methyl-3-isobutanol-Δ ² -cyclohexene§...	Me ₂ CO	0.8		68.2	
C ₁₆ H ₂₄ O	1-Methyl-3-phenyl-4-isopropyl-3-cyclohexanol.....		0.9843	20	-16.32	(1481)



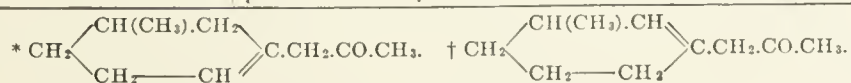
Alcohols derived from menthol (for menthol itself (IIC₂B), see p. 420)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₀ H ₁₈ O	<i>d</i> -Δ ⁶ - <i>m</i> -Menthenol (8).....	EtOH	4.405	16	36.7	(1600)
	<i>d</i> -Δ ⁶ - <i>m</i> -Menthenol (8).....	AcOEt	5		-2.7	(840)
	<i>d</i> -Δ ³ - <i>m</i> -Menthenol (8).....	AcOEt	3.62		20.9	(1312)
	<i>d</i> -Δ ³ - <i>p</i> -Menthenol (8) <i>cf.</i> (173.5, 434.5, 565, 566, 1158, 1158.5, 1491, 2029).....	AcOEt	4.55		83.2	
		C ₆ H ₆		18	67.0	(1048)
	<i>d</i> -Δ ² - <i>m</i> -Menthenol (8).....		0.923 ₂₂ ²²		55.56	(841)
C ₁₁ H ₁₈ O	<i>l</i> -Δ ¹ - <i>m</i> -Menthenol (8).....	AcOEt	5		-45.9	(840)
	2-Methyl-Δ ^{6,8(9)} -menthadiene-2-ol.....		0.9471 ₄ ^{20.4}	20.4	36.08	(1089)
C ₁₃ H ₂₂ O	2-Propyl-Δ ^{6,8(9)} -menthadiene-2-ol.....		0.9178 ₄ ²¹	21	49.16	(1090)
C ₁₆ H ₂₀ O	2-Phenyl-Δ ^{6,8(9)} -menthadiene-2-ol.....		1.0156 ₄ ^{15.1}	15.1	81.42	(1089)
<i>Terpene alcohols</i>						
C ₁₀ H ₁₃ N	Myrtenyl nitrile.....		0.967 ₂₀ ²⁰	20	46	(1924)
C ₁₀ H ₁₅ Cl	Myrtenyl ehloride.....		1.015 ₂₀ ²⁰	20	23.6	(1924)
C ₁₀ H ₁₆ O	Myrtenol.....		0.9763 ₂₀ ²⁰	20	46.8	(1924)
C ₁₀ H ₁₈ O	Isopulegol.....		0.9154	17.5	-2.66	(1491)
C ₁₀ H ₁₈ O	Methyleamphenilol.....	EtOH	41.42	18.5	16.6	(61)
C ₁₀ H ₁₈ O	Homonopinol (pinene hydrate).....	Et ₂ O	17.85	18	-4.99	(2127)
C ₁₀ H ₂₀ O	Dihydrofencholenyl alcohol.....		0.8869 ₂₂ ²²		11.3	(1919)
C ₁₀ H ₂₀ O	<i>d</i> -(1)-Dihydrosylveterpineol.....	MeOH			1.96	(842)
C ₁₀ H ₂₀ O	Tetrahydroumbellulol.....		0.9071 ₁₅ ¹⁵	15	-6.6	(1183)
C ₁₁ H ₂₀ O	3-Methylisopulegol.....		0.9108 ₂₀ ²⁰	20	19.54	(1824)
C ₁₂ H ₂₀ O ₂	Methyleamphenilyl acetate*.....		1.003	18	18.9	(61)
C ₁₈ H ₂₂ O ₄	Myrtenyl hydrogen phthalate.....	EtOH	50		21.6	(1924)
DIHYDRIC ALCOHOLS						
C ₁₀ H ₂₀ O ₂	Sylveterpine.....	MeOH	8.12	15	27.43	(2118)
C ₁₀ H ₂₀ O ₂	α-Sylveterpine.....	CHCl ₃			-27.74	(842)
	β-Sylveterpine.....	CHCl ₃			20.93	
		MeOH			18.48	
POLYHYDRIC ALCOHOLS						
C ₂₂ H ₂₄ O ₇	Acetyltetramethylhematoxylin.....	AcOH	1.01	20	159.19	(863)
KETONES						
KETONES NOT DERIVED DIRECTLY FROM TERPENES						
<i>Cyclopentanones</i>						
C ₆ H ₁₀ O	3-Methylcyclopentan-1-one.....		0.9140 ₄ ¹⁹		156.3	(2232)
C ₆ H ₁₁ NO	3-Methyleyclopentanoneoxime.....	H ₂ O	2.41	20	75.15	(2112)
	3-Methyleyclopentanone-α-isooxime.....	H ₂ O	25.59	20	-36.12	
	3-Methyleyclopentanone-β-isooxime.....	H ₂ O	5.28	20	-22.20	
C ₇ H ₁₂ O	2, 3-Dimethyleyclopentanone.....		0.8914 ₄ ¹⁹	19	126.7	(808); <i>cf.</i> (2232)
C ₈ H ₁₄ O	2, 2, 3-Trimethyleyclopentanone.....		0.8778 ₄ ¹⁹	19	103.7	(808)
C ₉ H ₁₆ O	2, 3, 6, 6-Tetramethyleyclopentanone.....		0.8668 ₄ ¹⁹	19	70.1	(808)
C ₁₀ H ₁₆ O	3, 6-Dimethyl-2-allyleyclopentanone.....		0.8968 ₄ ²⁰	20	71.7	(808)
C ₁₀ H ₁₈ O	2, 2, 3, 6, 6-Pentamethyleyclopentanone....			20	32.9	(808)
C ₁₀ H ₁₈ O	4-Methyl-2-isobutyleyclopentanone.....	Et ₂ O	1.72		62	(386)
C ₁₃ H ₂₀ O	3, 6-Dimethyl-2, 6-diallyleyclopentanone....		0.8994 ₄ ²⁰	20	74.7	(808)
C ₁₆ H ₂₄ O	3, 6-Dimethyl-2, 2, 6-triallyleyclopentanone.		0.9179 ₄ ²⁰	20	73.2	(808)
<i>Cyclohexanones</i>						
C ₇ H ₁₂ O	3-Methyleyclohexan-1-one.....				12.7	(306)
		C ₆ H ₆	11.37		11.96	
		MeOH	11.47		8.15	
		EtOH	10.97		10.58	
			0.9173	15.3	13.33	(2113)
		EtOH	9.29	14	10.45	
		CHCl ₃	14.77	12	14.77	
		CCl ₄	37.22	12.5	11.86	
		Et ₂ O	24.8	15	17.44	
C ₇ H ₁₃ NO	3-Methyleyclohexanoneoxime.....	Et ₂ O	11.70	21	-42.05	(2113)
		MeOH	9.98	22	-42.07	
C ₈ H ₁₄ O	3, 6-Dimethyleyclohexanone.....		0.9083 ₁₃ ¹³		11.6	(1200)
C ₉ H ₁₆ O	3-Methyl-6-ethyleyclohexanone.....		0.9016	15	8.53	(795)
C ₁₀ H ₁₆ O	3-Methyl-6-allyleyclohexanone.....		0.9233	15	18.03	(795)
C ₁₀ H ₁₈ O	3-Methyl-6-propyleyclohexanone.....		0.8994	15	3.35	(795)

* CH₃.C₉H₁₄O.CO.CH₃.

Cyclohexanones.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _{<i>D</i>}	Lit.
C ₁₁ H ₂₀ O	3-Methyl-6-isobutylcyclohexanone.....		0.9950	15	0.40	(795)
C ₁₁ H ₂₀ O	2, 2, 3, 6, 6-Pentamethylcyclohexanone.....		0.8979 ²⁰		24	(800)
C ₁₃ H ₂₀ O	3-Methyldi-6, (?)-allylcyclohexanone.....		0.9365	15	62.03	(795)
C ₁₄ H ₁₇ NO ₂	Benzoyl-3-methylcyclohexanoneoxime, α-.....	Et ₂ O	7.49	22	19.97	(2113)
	β-.....	Et ₂ O	7.23		—86.08	
C ₁₄ H ₁₈	6-Benzylidene-3-methylcyclohexanone.....	EtOH	1.35		—152	(794)
C ₁₅ H ₁₈ O ₂	6-Anisylidene-3-methylcyclohexanone.....	EtOH	0.525		—225	(794)
C ₁₆ H ₂₆ O	3-Methyl-2, 2-diallyl-6-isopropylcyclohexanone.....				25.50	(800)
C ₁₇ H ₂₂ O	6-Cuminyldiene-3-methylcyclohexanone.....	EtOH	1.51		—165	(794)
C ₁₉ H ₂₈ O	3-Methyl-2, 2, 6, 6-tetraallylcyclohexanone.....		0.954	15	36.17	(800)
<i>Other ketones not derived directly from terpenes</i>						
C ₁₀ H ₁₆ O	<i>d</i> -1-Methyl-3-acetonyl-Δ ³ -cyclohexene*.....	Me ₂ CO	1.0		82.8	(837.5)
	<i>d</i> -1-Methylacetonyl-Δ ² -cyclohexene†.....	Me ₂ CO			60.7	
C ₁₁ H ₁₉ N ₃ O	<i>d</i> -1-Methyl-3-acetonyl-Δ ³ -cyclohexene semicarbazone.....	Me ₂ CO	0.75		70.4	(837.5)
	<i>d</i> -1-Methyl-3-acetonyl-Δ ² -cyclohexene semicarbazone.....	Me ₂ CO			57.8	
KETONES DERIVED FROM TERPENES						
<i>Carvone and derivatives</i>						
C ₁₀ H ₁₄ O	<i>d</i> -Carvone $\left(\text{CH}_3.\text{C} \begin{array}{l} \diagup \text{CO.CH}_2 \\ \diagdown \text{CH.CH}_2 \end{array} \text{CH.C} \begin{array}{l} \diagup \text{CH}_3 \\ \diagdown \text{CH}_2 \end{array} \right)$		0.9567		173.8	(71)
			0.959	20	62.2	(143); <i>cf.</i> (570, 2055)
C ₁₀ H ₁₄ OS	<i>l</i> -Carvone.....	CHCl ₃	10	20	—62.46	
	<i>d</i> -Carvone thiolsulfide.....	CHCl ₃	10	20	5.5	(143); <i>cf.</i> (306)
C ₁₀ H ₁₆ N ₃ O	<i>l</i> -Carvone thiolsulfide.....	CHCl ₃	10	20	—5.5	
	<i>d</i> -Triazodihydrocarvone.....				88.49	(596)
		CHCl ₃	4.117		94.4	
	<i>l</i> -Triazodihydrocarvone.....				—92.47	
		CHCl ₃	4.139		—94.22	
C ₁₀ H ₁₆ O	Dihydrocarvone.....			20	18.28	(306)
C ₁₀ H ₁₆ O ₂	8-Hydroxy-8, 9-dihydrocarvone.....	EtOH	9.96	20	43.06	(1841)
C ₁₀ H ₁₈ O	Tetrahydrocarvone (λ = 5780).....		0.904	20	—40.5	(2063)
C ₁₁ H ₁₆ Br ₂ NO	α-Cyanodihydrocarvone dibromide.....	EtOH	1.59	18	29.0	(1169)
C ₁₁ H ₁₆ NO	β-Cyanodihydrocarvone.....	EtOH	1.447		—42.1	(1174)
	Neocyanodihydrocarvone.....	EtOH	1.340	12	62.7	
C ₁₁ H ₁₆ NO	Cyanodihydrocarvone.....	EtOH	1.68	12	13.5	(1169)
C ₁₁ H ₁₆ N ₂ O	α-Cyanodihydrocarvoxime.....	EtOH	1.59	17	14.2	(1169)
	β-Cyanodihydrocarvoxime.....	EtOH	1.59	17	6.0	
C ₁₁ H ₁₆ O ₃	α-Dihydrocarvonecarboxylic acid.....	AcOEt	1.63	16.5	49.9	(1169)
	β-Dihydrocarvonecarboxylic acid.....	AcOEt	1.62	35	28.8	
C ₁₁ H ₁₇ N ₃ O	Carvone semicarbazone (M. P. 162).....	Py	5.12	20	115.1	(1823)
	(M. P. 141–142).....	Py	5.00	20	113.3	
C ₁₇ H ₂₀ O ₂	β-Benzoyldihydrocarvone.....	EtOH	0.995	18	—50.7	(327)
	On adding <i>M</i> NaOEt.....	EtOH	0.995	18	—40.2	
C ₂₃ H ₂₅ NO	β-Phenyliminobenzoyldihydrocarvone.....	EtOH	1.00	17	—369	(327)
<i>Carvoxime and derivatives</i>						
C ₁₀ H ₁₅ NO	β-Carvoxime.....	C ₆ H ₆			68.3	(380); <i>cf.</i> (2107)
C ₁₀ H ₁₅ NO	<i>d</i> -Carvoxime.....	EtOH	9.84	20	39.6	(728); <i>cf.</i> (382, 727.5)
C ₁₂ H ₁₇ NO ₂	Acetyl- <i>d</i> -carvoxime.....	C ₆ H ₆	10.03		43.0	(728)
C ₁₄ H ₁₉ NO ₂	Crotonyl- <i>d</i> -carvoxime.....	C ₆ H ₆	10.00	20	33.5	(1812)
C ₁₇ H ₁₉ BrNO ₂	<i>o</i> -Bromobenzoyl- <i>d</i> -carvoxime.....	CHCl ₃	5.469	22.0	26.0	(728)
	<i>m</i> -Bromobenzoyl- <i>d</i> -carvoxime.....	CHCl ₃	5.513	23.5	18.2	
	<i>p</i> -Bromobenzoyl- <i>d</i> -carvoxime.....	CHCl ₃	5.496	23	14.9	



Carvoxime and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₇ H ₁₈ N ₂ O ₄	<i>o</i> -Nitrobenzoyl- <i>d</i> -carvoxime.....	CHCl ₃	4.704	20	±0.00	(728)
	<i>m</i> -Nitrobenzoyl- <i>d</i> -carvoxime.....	CHCl ₃	4.585	23.5	20.7	
	<i>p</i> -Nitrobenzoyl- <i>d</i> -carvoxime.....	CHCl ₃	4.565	22.5	17.3	
C ₁₇ H ₁₉ NO ₂	Benzoyl- <i>d</i> -carvoxime.....	CHCl ₃	9.106	18.5	26.6	(728); <i>cf.</i> (382)
		C ₆ H ₆	9.88		11.6	(1812)
	Benzoyl-β-carvoxime.....	C ₆ H ₆			75.3	(380)
C ₁₇ H ₂₀ N ₂ O ₂	Carbanilido- <i>d</i> -carvoxime.....	CHCl ₃	2.720	18	31.7	(728)
C ₁₈ H ₂₁ NO ₂	Phenylacetyl- <i>d</i> -carvoxime.....	CHCl ₃	7.781	22	40.6	(728)
		C ₆ H ₆	10.05		24.5	(1812)
	<i>o</i> -Toluy- <i>d</i> -carvoxime.....	CHCl ₃	9.19	15.5	27.1	(728)
C ₁₈ H ₂₁ NO ₂	<i>m</i> -Toluy- <i>d</i> -carvoxime.....	CHCl ₃	10.02	15.5	26.9	
	<i>p</i> -Toluy- <i>d</i> -carvoxime.....	CHCl ₃	9.295	15.5	23.4	
	Carbo- <i>o</i> -toluido- <i>d</i> -carvoxime.....	CHCl ₃	2.755	18	27.4	(728)
C ₁₈ H ₂₂ N ₂ O ₂	Carbo- <i>m</i> -toluido- <i>d</i> -carvoxime.....	CHCl ₃	2.740	18	29.8	
	Carbo- <i>p</i> -toluido- <i>d</i> -carvoxime.....	CHCl ₃	2.711	20	30.8	
	Cinnamoyl- <i>d</i> -carvoxime.....	C ₆ H ₆	10.59	20	15.4	(1812)
C ₁₉ H ₂₁ NO ₂	Dihydrocinnamoyl- <i>d</i> -carvoxime.....	C ₆ H ₆	10.00	20	26.2	(1812)
C ₁₉ H ₂₃ NO ₂	α-Methylcinnamoyl- <i>d</i> -carvoxime.....	C ₆ H ₆	10.04	20	16.3	(1812)
C ₂₀ H ₂₃ NO ₂	β-Methylcinnamoyl- <i>d</i> -carvoxime.....	C ₆ H ₆	9.94	20	22.5	
	α-Methylhydrocinnamoyl- <i>d</i> -carvoxime.....	C ₆ H ₆	9.95	20	23.9	(1812)
	β-Methylhydrocinnamoyl- <i>d</i> -carvoxime.....	C ₆ H ₆	9.88	20	22.8	
C ₂₀ H ₂₅ NO ₂	Diphenylacetyl- <i>d</i> -carvoxime.....	C ₆ H ₆	9.90	20	17.6	(1812)
C ₂₄ H ₂₅ NO ₂	α-Phenylcinnamoyl- <i>d</i> -carvoxime.....	C ₆ H ₆	10.03	20	37.1	(1812)
C ₂₅ H ₂₅ NO ₂	β-Phenylcinnamoyl- <i>d</i> -carvoxime.....	C ₆ H ₆	10.08	20	26.4	
C ₂₅ H ₂₇ NO ₂	α-Phenylhydroxycinnamoyl- <i>d</i> -carvoxime....	C ₆ H ₆	9.99	20	12.5	(1812)
	β-Phenylhydroxycinnamoyl- <i>d</i> -carvoxime....	C ₆ H ₆	9.73	20	20.1	
<i>Menthone and derivatives</i>						
C ₁₀ H ₁₆ O	Δ ⁴ -Menthenone.....	MeOH	14.62	18	-67.46	(2124)
	Δ ³ -Menthenone.....			20	-78.04	(306)
C ₁₀ H ₁₆ Br ₂ O	Dibromomenthone.....	CCl ₄	3.05		199.4	(104)
C ₁₀ H ₁₈ O	<i>d</i> - <i>p</i> -Menthone*.....	EtOH	7.57		30.20	(1121)
C ₁₀ H ₁₈ O ₂	8-Hydroxymenthane-2-one†.....	EtOH	18.5	20	-18.5	(1101)
C ₁₀ H ₁₉ NO	<i>l</i> -Menthone oxime.....	EtOH	10	20	42.51	(101)
C ₁₀ H ₁₉ NO	<i>l</i> -Isomenthone oxime.....	EtOH	24	21	-52.25	(144.5)
C ₁₀ H ₁₉ NO	<i>d</i> -Isomenthone oxime.....	EtOH	20	20	-4.85	(101, 1491)
C ₁₀ H ₂₀ ClNO	<i>d</i> -Isomenthone oxime hydrochloride.....	EtOH	10		-24.48	(101)
C ₁₀ H ₂₀ ClNO	<i>l</i> -Menthone oxime hydrochloride.....	EtOH	10	20	61.16	(101)
C ₁₇ H ₂₂ O ₂	Benzoylmenthone (enol form).....	C ₆ H ₆		20.5	32.11	(157)
C ₁₇ H ₂₂ O	Benzylidenementhone (form A).....	EtOH	6		-186.1	(1395)
		CHCl ₃	6		-185.8	
	(form B).....	EtOH	3		-261.1	
C ₁₇ H ₂₂ O		CHCl ₃	6		-258.0	
	Benzylidenementhone (form A).....	EtOH	6		-185.83	(1394)
	(form B).....	EtOH	6		-258.08	
C ₁₇ H ₂₃ NO ₂	<i>l</i> -Menthone oxime benzoyl derivative.....	Et ₂ O	9.89		1.9	(2113)
C ₁₇ H ₂₄ O	Benzylmenthone.....	C ₆ H ₆		23	28.4	(158)
C ₁₈ H ₂₆ O	Menthonylmethylphenylmethane†.....	C ₆ H ₆		19	95.27	(157)
C ₁₈ H ₂₄ O ₂	Anisylidenementhone.....	CHCl ₃	3.4		-278.43	(1395)
C ₁₉ H ₂₈ O	Menthonylphenylethylmethane.....	C ₆ H ₆			-17.57	(156)
C ₂₁ H ₃₂ O	Menthonylisoamylphenylmethane.....	C ₆ H ₆		20.5	13.75	(157)
C ₂₃ H ₂₈ O	Menthonyldiphenylmethane§ (isomeride (a))	C ₆ H ₆			-158.5	(156)
	(isomeride (b))	C ₆ H ₆			0	
C ₂₄ H ₂₄ O	Dibenzylidene-Δ ⁴ -menthenone.....	CHCl ₃	2.92	20	-58.41	(2124)
C ₂₅ H ₃₀ O ₂	Menthonylmethylphenylmethane benzoate	C ₆ H ₆		20.5	145.7	(157)
C ₂₉ H ₃₈ O ₂	Menthonylisoamylphenylmethane benzoate ¶	C ₆ H ₆	?	19.5	186.5	(157)

* CH₃.CH<CH₂.CO / CH₂.CH< CH₂.CH< CH₃.CH(CH₃)₂. † Dihydroxycarvone hydrate.

‡ C₈H₁₆<CH₃.CH(CH₃).C₆H₅ / CO . § C₁₀H₁₇O.CH(C₆H₅)₂. || C₈H₁₆<C.CH(CH₃).C₆H₅ / C.O.CO.C₆H₅, derived from enolic isomeride of the ketone.

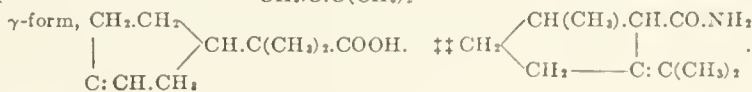
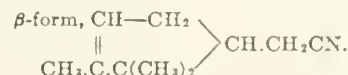
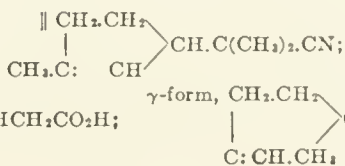
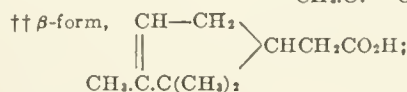
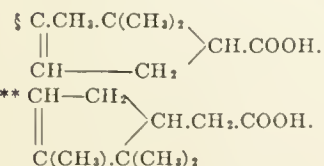
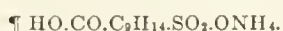
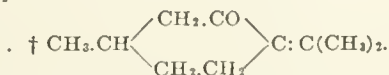
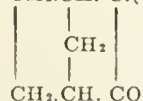
¶ C₈H₁₆<C.CH(C₆H₁₁).C₆H₅ / C.O.CO.C₆H₅, derived from enolic isomeride of the ketone.

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _{<i>D</i>}	Lit.
C ₉ H ₁₄ O	Camphenilone*	C ₆ H ₆	10	19	-61.21	(1256)
C ₉ H ₁₄ O	Nopinone		0.983	18	18.48	(2127)
		C ₆ H ₆	12.36	17	10.95	
		Et ₂ O	7.15	14	11.02	
		EtOH	7	18	38.04	
C ₁₀ H ₁₄ O	<i>d</i> -Verbenone		0.978 ₄ ²⁰	18	249.6	(154)
		EtOH	9.04	18	229.6	
		C ₆ H ₆	8.25	18	245.7	
C ₁₀ H ₁₄ O	<i>l</i> -Verbenone		0.982 ¹⁵		-146.6	(154)
C ₁₀ H ₁₄ O	Umbellulone		0.958 ²⁰		31.5	(1920)
C ₁₀ H ₁₄ Br ₂ O	Dibromodihydroumbellulone	CHCl ₃	2.10		6.4	(1183)
C ₁₀ H ₁₅ BrO	Bromodihydroumbellulone	CHCl ₃	1.67		-70.1	(1183)
C ₁₀ H ₁₆ O	Dihydro- <i>d</i> -verbenone		0.966 ¹⁸	18	52.19	(154)
C ₁₀ H ₁₆ O	β-Dihydroumbellulone		0.928 ²⁰		-33.08	(1920)
C ₁₀ H ₁₆ O	Carvotanacetone (λ = 5780)		0.937	18	59.8	(2063)
C ₁₀ H ₁₆ O	Pulegone†		0.9293	23	25.35	(78)
			0.9323	20	22.89	(105)
C ₁₀ H ₁₆ N ₂ O ₄	Pulegone nitrosite	CHCl ₃		23	23.13	(714)
C ₁₁ H ₁₆ NO	Cyanocarone	EtOH	0.924	20	297	(328)
C ₁₁ H ₁₇ NO	Isopulegone oxime	MeOH	6.43	22	-25.83	(2121)

MONOCARBOXYLIC ACIDS†

$C_9H_{14}O_2$	Campholytic acid§.....		1.017 ₄ ¹⁵	10	—5	(2101.5); cf. (1527, 2104)
$C_9H_{16}IO_2$	<i>d</i> -Iododihydrocampholytic acid.....	CS ₂	4.2	28	99.4	(1527)
		CS ₂	3.2	28	97.8	
		CS ₂	2.9	23	92.9	
$C_9H_{16}O_2$	Dihydrocampholytic acid.....		0.9915 ₄ ²⁰	25	33.7	(1527)
$C_9H_{17}NO$	Dihydrocampholytic amide.....	ligroin	3.4	22	20.6	(1527)
$C_{10}H_{16}N$	α -Fencholenic nitrile (IID).....		0.9136 _{16.6} ^{15.6}	15.6	28.98	(334.5)
	β -Fencholenic nitrile (IID).....		0.9203 _{15.6} ^{15.6}	15.6	43.66	
$C_{10}H_{25}N$	Campholenic nitrile.....			23	45	(806)
		EtOH	4.64	23	53.9	
$C_{10}H_{16}O_6SNH_4$	Ammonium hydrogen sulfocampholene- carboxylate¶.....	H ₂ O	1.66		—6.9	(836)
$C_{10}H_{16}O_2$	α -Campholenic acid**.....			18	10.93	(1136)
$C_{10}H_{16}O_2$	β -Fencholenic acid††(IID).....	EtOH			19.64	(1922)
	γ -Fencholenic acid††.....		1.0087 ²⁰	20	52.5	(1923)
$C_{10}H_{17}NO$	α -Campholenic amide.....	EtOH	5	16	—4.33	(1136)
$C_{10}H_{17}NO$	Pulegenic amide††.....	MeOH	21.26	18	29.05	(2129)
$C_{10}H_{18}O_2$	α -Dihydrocampholenic acid.....		0.9773 _{20.6} ^{20.6}	15	24.98	(1136)
$C_{10}H_{18}O_2$	Dihydrofencholenic acid.....		0.9742 ₄ ¹⁵	15	4.10	(1919)
$C_{10}H_{19}NO$	α -Dihydrocampholenic amide.....	96% EtOH	5	16	26.43	(1136)
$C_{10}H_{19}NO$	Dihydropulegenic amide.....	MeOH	16.78	20	4.85	(2129)
$C_{11}H_{18}O_2$	Ethyl campholytate.....		0.962 ₄ ¹⁵	10	5.04	(2101.5)
$C_{11}H_{18}O_2$	Ethyl γ -lauronolate.....		0.9514 ₄ ²⁰	26	56.6	(1520)
$C_{11}H_{20}O_2$	Methyl dihydrofencholenate.....		0.9295 ²²	22	3.0	(1919)
$C_{12}H_{19}N$	α -Ethylcampholenic nitrile.....	EtOH	11.8	13	70.33	(1281)
$C_{12}H_{22}O_2$	Ethyl dihydrofencholenate.....		0.9129 ²⁰	20	3.50	(1919)
$C_{12}H_{22}O_2$	Ethyl α -dihydrocampholenate.....		0.9276 ₄ ^{14.8}	15.5	21.82	(1136)
$C_{13}H_{21}N$	Propylcampholenic nitrile.....	EtOH	22.6	16	46.52	(1281)

† For hydroxy derivatives, see p. 417; for amino derivatives, see p. 420.



Campholytic, campholenic and fencholenic acids (mainly 5-atom rings).—(Continued)

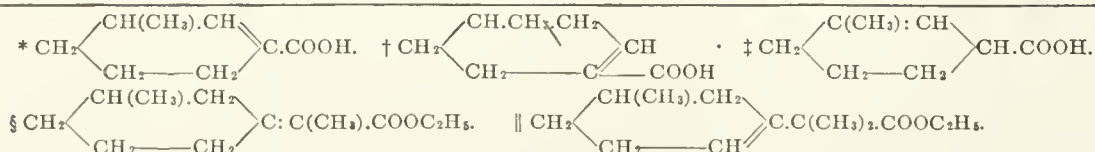
Formula	Name	Solvent	d, C % or	t, °C	[α] _D	Lit.
C ₁₃ H ₁₉ N	Allylcampholenic nitrile.....	EtOH	13.3	14	28.90	(1281)
		EtOH	21.0		28.66	
C ₁₇ H ₂₁ N	Benzylcampholenic nitrile.....	EtOH	18.7	17	54.07	(1281)
		EtOH	15.4	17	44.40	

Tetrahydrotoluic acids and homologues (6-atom rings, including derivatives of cyclohexylideneacetic acids)

C ₈ H ₁₂ Br ₂ O ₂	d-3, 4-Dibromo-1-methylcyclohexane-3-carboxylic acid.....	AcOEt	3.101		28.5	(1312)
C ₈ H ₁₂ Br ₂ O ₂	d-3, 4-Dibromo-1-methylcyclohexane-4-carboxylic acid.....	AcOEt	4.682		102.2	(288)
C ₈ H ₁₂ O ₂	d-1-Methyl-Δ ² -cyclohexene-3-carboxylic acid*.....	AcOEt	2.609		40.1	(1312)
C ₈ H ₁₂ O ₂	d-1-Methyl-Δ ³ -cyclohexene-4-carboxylic acid†	AcOEt	5.035		150.1	(288); cf. (1048)
C ₈ H ₁₂ O ₂	d-1-Methyl-Δ ⁵ -cyclohexene-3-carboxylic acid	AcOEt	5.044	16	33.1	(1600)
C ₈ H ₁₂ O ₂	l-1-Methyl-Δ ¹ -cyclohexene-3-carboxylic acid‡				-49.7	(840)
C ₈ H ₁₂ O ₂	d-1-Methyl-Δ ⁶ -cyclohexene-3-carboxylic acid				108	(840)
C ₉ H ₁₄ O ₂	l-1-Methylcyclohexylidene-4-acetic acid					
	(CH ₃ CH<CH ₂ .CH ₂ >C:CH.CO ₂ H).....	EtOH (abs.)	0.727		-81.1	(1601,
		EtOH (abs.)	1.593		-77.8	1601.5)
		MeOH	0.551		-74.6	
		Et ₂ O	0.806		-74.4	
		CH ₂ (OCH ₃) ₂	0.7506		-74.6	
	d-1-Methylcyclohexylidene-4-acetic acid.....	EtOH (abs.)	0.725		81.4	(1601,
						1601.5)
		EtOH (abs.)	1.475		78.0	
		MeOH	0.742		75.5	
		Et ₂ O	0.737		75.3	
		CH ₂ (OCH ₃) ₂	0.718		75.5	
C ₁₀ H ₁₆ O ₂	Ethyl d-1-methyl-Δ ³ -cyclohexene-3-carboxylate.....	AcOEt	3.074		32.5	(1312)
	Ethyl l-1-methyl-Δ ³ -cyclohexene-3-carboxylate.....	AcOEt	4.119		-28.9	
C ₁₀ H ₁₆ O ₂	Ethyl d-1-methyl-Δ ³ -cyclohexene-4-carboxylate.....	AcOEt	4.819	20	122.3	(288); cf. (1048)
C ₁₀ H ₁₆ O ₂	Ethyl d-1-methyl-Δ ⁵ -cyclohexene-3-carboxylate.....	AcOEt	4.760	16.5	30.5	(1600)
C ₁₂ H ₂₀ O ₂	Ethyl 1-methylcyclohexylidene-3-α-propionate§.....		0.9487 ₄ ¹⁶		48.41	(2236)
C ₁₃ H ₂₂ O ₂	Ethyl 1-methyl-Δ ³ -cyclohexenyl-3-α-isobutyrate 		0.9460 ₄ ¹⁸		45.59	(2236)

Other cyclic monocarboxylic acids

C ₁₀ H ₉ NO ₄	5-Nitrohydrindene-2-carboxylic acid.....	H ₂ O	0.405	20	29.6	(1425)
		H ₂ O	0.405	20	36.4	
C ₁₁ H ₁₂ O ₂	d-3-Methylhydrindene-2-carboxylic acid					
	(C ₆ H ₄ <CH(CH ₃)>CH.CO ₂ H).....	EtOH	1.88		67.66	(1513)
		C ₆ H ₆	1.23		76.86	
		PhMe	0.979		89.33	
	Barium salt.....	H ₂ O	2.06		24.02	(1513)
C ₁₂ H ₁₄ O ₂	Methyl d-3-methylhydrindene-2-carboxylate.....	EtOH	1.07		63.22	(1513)
C ₁₈ H ₃₂ O ₂	Chaulmoogric acid.....	CHCl ₃	3.89		56	(1696)
		C ₆ H ₆	10	20	61.8	(1195)
C ₁₈ H ₃₃ NO	Chaulmoogramide.....	CHCl ₃	4.3	27	57.3	(1696)



Other cyclic monocarboxylic acids.—(Continued)

Formula	Name	Solvent	d , C or %	t , °C	$[\alpha]_D$	Lit.
$C_{19}H_{34}O_2$	Methyl chaulmoograte.....	$CHCl_3$	5	15	50	(1696)
$C_{20}H_{36}O_2$	Ethyl chaulmoograte.....		0.9119 ₂₆ ²⁵ 0.9079 ₁₆ ¹⁶	15 20	50.5 50.7	(1696)
OXY AND HYDROXY ACIDS						
$C_4H_5O_3K$	Potassium d - α -methylglycidate*.....	H_2O	9.96	20	-17.57	(1047)
$C_9H_{14}N_2O_2$	Nitrosoaminodihydrocampholic anhydride†..	$EtOH$	2.5	25	-83.3	(1527)
$C_9H_{14}O_2$	d -trans-Hydroxydihydrocampholytic lactone	$EtOH$	10	27	121.9	(1527)
$C_9H_{16}O_3$	l -trans-Hydroxydihydrocampholytic acid....	H_2O	1.45		-70.04	(1522)
$C_9H_{16}O_3$	d -trans-Hydroxydihydrocampholytic acid†..	$AcOEt$	8		70.1	(1527)
	d -cis-Hydroxydihydrocampholytic acid.....	$EtOH$	8.2		50.8	
$C_9H_{17}NO_2$	Aminodihydrocampholytic acid.....	H_2O	5	25	54.7	(1528)
$C_9H_{18}ClNO_2$	Aminodihydrocampholytic acid hydrochloride	H_2O	10	26	41.3§	(1528)
$C_{10}H_{14}O_4$	d -Cineolic anhydride.....	C_6H_6	8.20	20	45.37	(1840)
$C_{10}H_{16}O_2$	l -Dihydrocarvenolide (dihdropulegenolide, lactone of dihydrocarvenolic acid).....	$MeOH$	21.8	18	-57.57	(2129)
		$MeOH$	22.34	19	-56.85	
$C_{10}H_{16}O_3$	Nopinic acid 	Et_2O	16.1	17	-15.64	(2127)
$C_{10}H_{16}O_3$	dl -Hydroxyfenchenic acid¶.....	Et_2O	7.57	13	-62.98	(2130)
$C_{10}H_{16}O_3$	Pulegenolic acid (oxidation product).....	$MeOH$	21		-18.44	(2129)
	Pulegenic oxylactone (oxidation product)...	$MeOH$	17.45	20	-10.27	
$C_{10}H_{16}O_5$	Ascaridolic acid** (1, 4-cineolic acid).....	$CHCl_3$	8.22	24	13.93	(1493)
$C_{10}H_{16}O_5$	l -Cineolic acid††.....	H_2O	7.33	20	-19.10	(1840)
$C_{10}H_{17}NO$	Hydroxydihydrofenchonitrile††.....		0.9792 ₁₆ ¹⁵	18	-8	(1359)
$C_{10}H_{18}O_3$	Dihydrocarvenolic acid§§.....	Et_2O	12.298	17	9.43	(2129)
$C_{11}H_{20}O_3$	Ethyl 1-methylcyclohexan-3-ol-3-acetate ..		0.9984 ₄ ¹⁹		-1.53	(2236)

KETONIC ACIDS

Four-atom rings

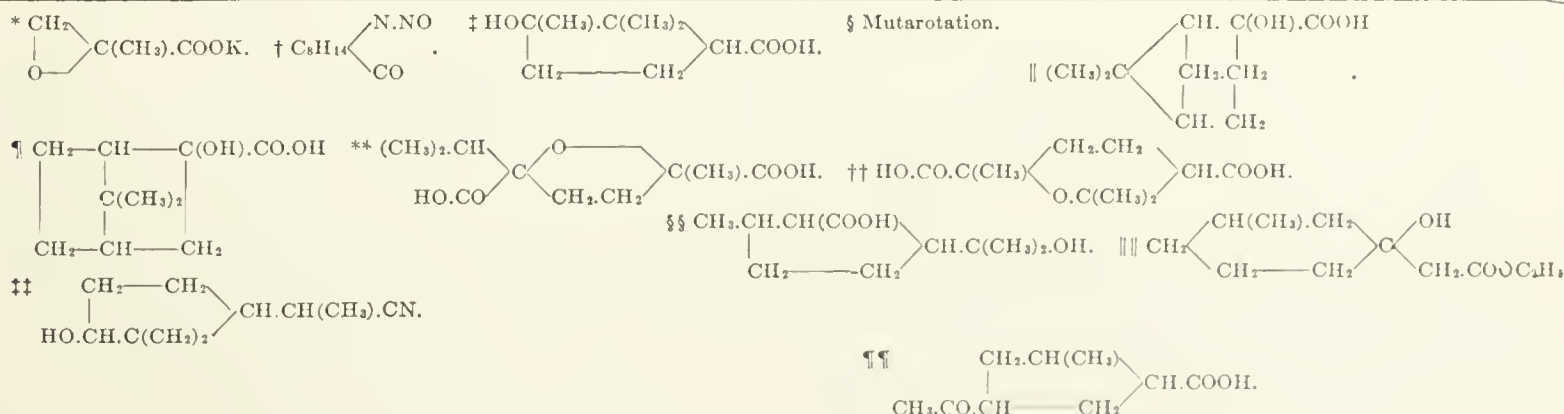
$C_{10}H_{16}O_3$	l -Pinonic acid } d -Pinonic acid }					
	$\left(CH_3.CO.CH \begin{array}{c} \text{CH}_2 \\ \diagup \quad \diagdown \\ C(CH_3)_2 \end{array} CH.CH_2.CO.OH \right)$	$\left\{ \begin{array}{l} CHCl_3 \\ CHCl_3 \end{array} \right.$		22 25	-90.5 89.0	(83)

Five-atom rings

$C_8H_{12}O_3$	Methyl 4-methyl-2-cyclopentanone- carboxylate.....		1.07	15	91.11	(811)
$C_9H_{14}O_3$	Umbellonic acid¶¶.....	$CHCl_3$	2.14		377.6	(2044)
$C_9H_{14}O_3$	Ethyl 4-methyl-2-cyclopentanonecarboxylate		1.05	15	78.40	(811)
$C_{10}H_{16}O_3$	Propyl 4-methyl-2-cyclopentanonecarboxy- late.....		1.029	15	64.75	(811)
$C_{11}H_{18}O_3$	Isobutyl 4-methyl-2-cyclopentanonecar- boxylate.....		0.956 ₂₀ ²⁰	15	66.15	(811)

Six-atom rings (including hydrindone)

$C_8H_{12}O_3$	d -1-Methylcyclohexan-3-one-4-carboxylic acid.....	$EtOH$	2.40	17	97.2	(709)
$C_{10}H_{16}O_3$	Ethyl d -1-methylcyclohexan-3-one-4- carboxylate.....	$EtOH$	2.17	17.5	84.2	(709)
$C_{11}H_{17}NO$	Menthoncarboxylic anhydramide.....	$EtOH$	1.01	17	66.6	(326)



Six-atom rings (including hydrindone).—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₁ H ₁₈ O ₃	Carvomenthonecarboxylic acid*.....	AcOEt	1.53	22	−4.3	(1170)
C ₁₁ H ₁₈ O ₃	Menthonecarboxylic acid†.....	EtOH	1		−23.0	(326)
C ₁₂ H ₁₈ O ₂	Pulegoneacetic anhydride, enolic (for pulegol-acetic anhydride, see p. 428).....	EtOH	7.57	20	71.61	(2078)
C ₁₂ H ₁₈ O ₆	<i>d</i> -Isomenthonedicarboxylic acid‡.....	EtOH	1.728	17	124.4	(709)
C ₁₂ H ₁₉ NO	Pulegoneacetamide anhydride.....	EtOH	1.59	20	65.99	(2078)
C ₁₂ H ₂₀ O ₃	Pulegoneacetic acid§.....	EtOH	1.084	20	−3.2	(2078)
C ₁₃ H ₂₂ O ₃	Methyl pulegoneacetate.....	MeOH	3.29	20	−6.88	(2078)
C ₁₄ H ₂₀ O ₄	Pulegonemalonic anhydride methyl ester....	98% MeOH	3.61	20	26.6	(2078)
C ₁₄ H ₂₄ O ₃	Ethyl pulegonacetate.....	EtOH	3.61	20	−1.13	(2078)
C ₁₅ H ₂₄ O ₆	Dimethyl pulegonemalonate.....	MeOH	3.15	20	−8.79	(2078)
C ₁₇ H ₂₈ O ₆	Diethyl pulegonemalonate.....	EtOH	4.58	20	−3.27	(2078)
C ₁₇ H ₁₂ O ₃	Dihydroisocumarinhydrindone-2, 3-spirane .	C ₆ H ₆	1.52	20	−65	(1206)
C ₁₇ H ₁₃ ClO ₃	<i>d</i> -β-Chloro-β-(benzyl- <i>o</i> -carboxylic acid)-hydrindone¶.....	AcOH	2.92	20	130	(1206)

DICARBOXYLIC ACIDS

Three-atom rings

C ₆ H ₆ O ₄	3-Methylcyclopropene-1, 2-dicarboxylic acid H ₂ O				179.8	(449.5)
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Four-atom rings

C ₁₁ H ₁₈ O ₄	Dimethyl pinate**.....		1.0582 ²⁰	20	13.9	(1924)
			1.0548	20	9	(1928)
C ₂₄ H ₂₀ ClNO ₂	<i>d</i> -α-Truxillanilidyl chloride.....	Me ₂ CO	3.78	20	12.42	(1987)
	<i>l</i> -γ-Truxillanilidyl chloride (impure).....	Me ₂ CO	2.73	19	−9.53	
C ₂₄ H ₂₁ NO ₃	<i>l</i> -α-Truxillanilidic acid††.....	Me ₂ CO	5.0	19	−23.0	(1987)
	<i>d</i> -γ-Truxillanilidic acid.....	Me ₂ CO	3.15	21	48.73	
C ₂₄ H ₂₂ N ₂ O ₂	<i>l</i> -α-Truxillanilidic amide.....	Me ₂ CO	1.35	20	−28.8	(1987)
	<i>d</i> -γ-Truxillanilidic amide.....	Me ₂ CO	1.56	19	35.6	(1987)
C ₂₆ H ₂₃ NO ₃	Methyl <i>l</i> -α-truxillanilidate.....	Me ₂ CO	3.35	20	−22.4	(1987)
	Methyl <i>l</i> -γ-truxillanilidate.....	Me ₂ CO	5.01	18	−38.55	
C ₂₆ H ₂₅ NO ₃	Ethyl <i>d</i> -α-truxillanilidate.....	Me ₂ CO	4.48	20	18.75	(1987)
	Ethyl <i>d</i> -γ-truxillanilidate.....	Me ₂ CO	2.461	18	25.19	

Five-atom rings

C ₇ H ₁₀ O ₄	<i>d</i> -trans-Cyclopentane-1, 2-dicarboxylic acid..	H ₂ O	0.876		87.6	(733)
C ₇ H ₁₀ O ₄	<i>d</i> -trans-Cyclopentane-1, 3-dicarboxylic acid..	H ₂ O	5.040		5.86	(1604)
C ₁₁ H ₁₈ O ₄	Diethyl <i>d</i> -trans-cyclopentane-1, 3-dicarboxylate.....	EtOH	6.291		5.01	(1604)
C ₈ H ₁₂ O ₄	Umbellaric acid‡‡.....	CHCl ₃	2.04		−89.7	(2044)
C ₁₀ H ₁₆ O ₄	Camphenecamphoric acid§§.....	EtOH	20.9	16	−1.166	(2118)

Six-atom rings

C ₁₂ H ₁₆ O ₄	2-Methyl-5-isopropenyl-Δ ² -tetrahydroisophthalic acid.....	EtOH	1.59	19.5	−172.8	(1170)
C ₁₂ H ₁₈ O ₄	2-Methyl-5-isopropenylhexahydroisophthalic acid.....	EtOH	0.93	17	−16.6	(1170)
C ₁₄ H ₂₄ O ₄	Ethyl 1-methylcyclohexane-3-malonate.....				−58	(529.5)

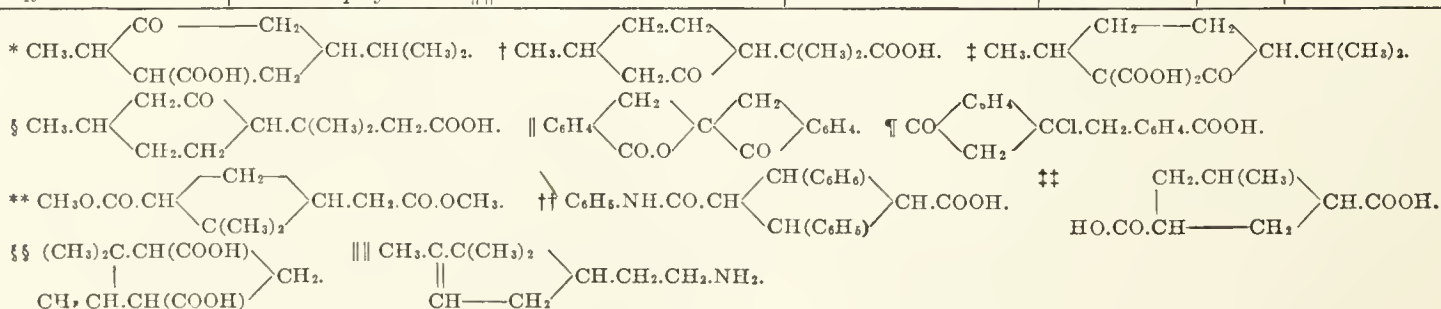
TRICARBOXYLIC ACIDS

C ₈ H ₁₀ O ₆	<i>dl</i> -trans-Cyclopentane-1, 2, 3-tricarboxylic acid.....	H ₂ O	1.007		72.4	(1603)
C ₁₆ H ₂₄ O ₆	Trimethyl 1-carboxy-3-methylcyclohexanylsuccinate.....		1.140 ²⁰	20	−27.8	(1934)

AMINES

MONOAMINES

C ₁₀ H ₁₉ N	<i>d</i> -α-Camphylamine 		0.8688	20	3.83	(1681)
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Pilocarpine and related compounds including pilosine (IIC₂B), anhydropilosine and pilosinine.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₁ H ₁₄ N ₂ O ₄	Isopilocarpinolactone.....	EtOH	4.05	16	−51.9	(1015)
C ₁₆ H ₁₆ N ₂ O ₂	Anhydropilosine*.....	90% EtOH	3.571		66.2	(1750)
	(after boiling).....	KOH	3.142		−132.7	(1750)
C ₁₆ H ₁₆ N ₂ O ₃	Pilosine†.....	CHCl ₃	1.168		40.2	(1750)
		EtOH	0.827		39.9	
C ₁₈ H ₁₈ N ₂ O ₆	Anhydropilosine oxalate.....	H ₂ O	4.093		−17.8	(1750)
C ₂₀ H ₂₄ N ₂ O ₉	Pilosine hydrogen <i>d</i> -tartrate.....	H ₂ O	3.838		24.2	(1750)
C ₃₂ H ₃₄ N ₄ O ₈ S	Anhydropilosine sulfate.....	H ₂ O	4.064		−17.6	(1750)
C ₃₂ H ₃₈ N ₄ O ₁₀ S	Pilosine sulfate.....	H ₂ O	4.454		21.0	(1750)

Other cyclic amino acids (nitrogen in ring)

C ₉ H ₁₆ NO ₂	Meroquinenic acid‡ (merochinen).....	H ₂ O	10	20	27.58	(1117)
C ₁₀ H ₁₆ N ₂	Methylmerochinen nitrile§.....	H ₂ O	0.971	20	17.11	(1754)

IICB. The Molecule Contains Two or More Asymmetric Atoms Attached Respectively to Two and Three Other Carbon Atoms
HYDROCARBONS AND HALIDES

C ₆ H ₁₁ I	1-Methyl-3-iodo-cyclopentane.....				−2.50	(306)
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ALCOHOLS

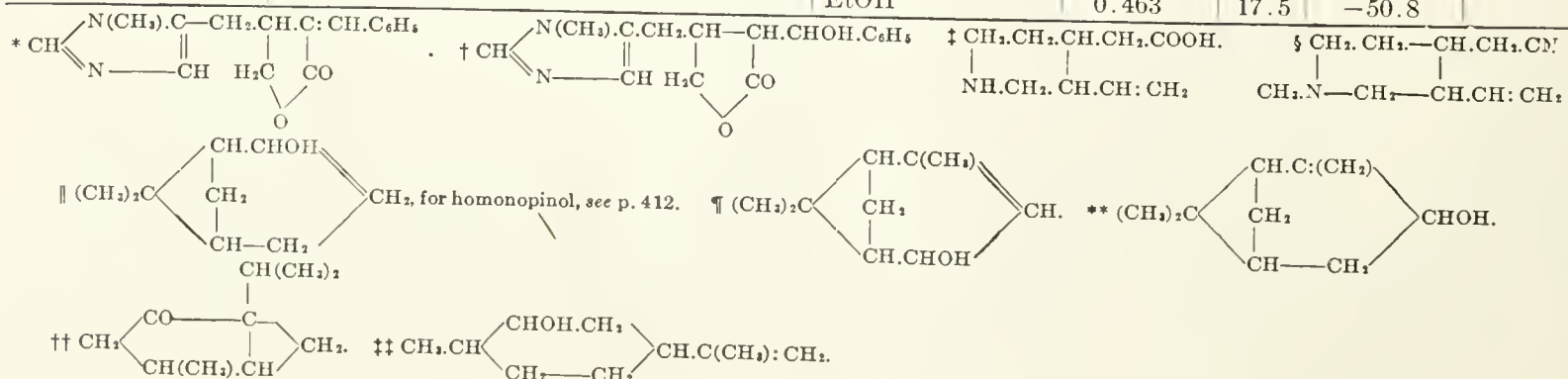
MONOHYDRIC ALCOHOLS

Cyclic alcohols not derived directly from terpenes

C ₇ H ₁₄ O	1, 3-Methylcyclohexanol.....			20	4.16	(306)
C ₆ H ₁₂ O	1, 3-Methylcyclopentanol.....				−4.89	
C ₁₀ H ₁₈ O	1, 3-Methylcyclohexanyl allyl ether.....		0.8738 ₄ ¹⁵		−14.33	(814)
C ₁₀ H ₂₀ O	1-Methyl-4-propyl-3-cyclohexanol.....		0.8976 ₄ ¹⁴	19	−18	(816)
C ₁₁ H ₂₂ O	1-Methyl-4-isobutyl-3-cyclohexanol.....	EtOH			−70.37	(816)
	1-Methyl-4-isobutyl-3-cyclohexanol (liquid isomeride).....				−18.01	
C ₁₂ H ₂₄ O	1, 2, 2-Trimethyl-5-isopropylcyclohexan-6-ol.....				3.23	(800)
C ₁₄ H ₂₀ O	4-Benzyl-1-methyl-3-cyclohexanol.....	EtOH			−53.35	(817)
C ₁₆ H ₂₀ O	4-Anisyl-1-methyl-3-cyclohexanol.....	EtOH	2.05		6.50	(815)
C ₁₉ H ₃₀ O	2-Methyl-1, 1, 5, 5-tetraallylcyclohexan-6-ol.....		0.9613	17	−9.25	(800)
C ₂₁ H ₂₆ O	2, 4-Dibenzyl-1-methyl-3-cyclohexanol.....	EtOH			−10.1	(817)

Terpene alcohols including menthol, homologues and derivatives

C ₉ H ₁₆ O	α-Nopinol 	Et ₂ O	12.53	18	−5.32	(2127)
	β-Nopinol.....	Et ₂ O	13.15	17	15.03	
C ₁₀ H ₁₆ O	<i>d</i> -Verbenol¶.....		0.9722 ¹⁸	18	132.3	(154)
C ₁₀ H ₁₆ O	Pinocarveol**.....	Et ₂ O	12.7	20	−52.45	(2115)
C ₁₀ H ₁₆ O	Dihydroumbellulol††.....		0.931 ²⁰		29.6	(1920)
C ₁₀ H ₁₈ O	Dihydrocarveol‡‡.....		0.9204 ₄ ²⁰		33.86	(299)
C ₁₀ H ₂₀ O	Carvomenthol (λ = 5780).....		0.908	20	−24.7	(2063); cf. (1128)
	(λ = 4359).....		0.908	20	−47.4	
C ₁₀ H ₂₀ O	Menthol (3-menthenol)	PhMe	5.39	20	−46.81	(306)
	(CH ₃ .CH<CH ₂ .CHOH>CH.CH(CH ₃) ₂)		0.8888 ₄₆ ⁴⁵	47	−49.88	(1599)
		CCl ₄	10.241	17.5	−46.58	(2100); cf. (50, 101,
		CCl ₄	0.529	17.5	−44.38	1048.5,
		Me ₂ CO	10.125	17.5	−47.94	1570.5,
		Me ₂ CO	0.475	17.5	−47.40	1589.5,
		AcOEt	9.823	17.5	−48.14	1868)
		AcOEt	0.473	17.5	−48.6	
		C ₆ H ₆	10.10	17.5	−46.02	
		C ₆ H ₆	2.91	17.5	−45.2	
		EtOH	9.63	17.5	−50.58	
		EtOH	0.463	17.5	−50.8	



Terpene alcohols including menthol, homologues and derivatives.—(Continued)

Formula	Name	Solvent	d, C or %	$t, ^\circ C$	$[\alpha]_D$	Lit.	
$C_{10}H_{20}O$	Menthol.—(Continued).....	EtOH (abs.)	5.03		-49.44	(1630)	
	<i>d</i> -Neomenthol.....		0.90		19.69	(1630)	
$C_{15}H_{26}O$	Selineol.....		0.9627	20	54.8	(1932)	
	<i>Ethers of menthol</i>						
$C_{11}H_{21}ClO$	<i>l</i> -Menthyl chloromethyl ether.....	$CHCl_3$	6.78	21	-172.57	(2137)	
$C_{13}H_{24}O$	<i>l</i> -Menthyl allyl ether.....		0.8763 ¹⁹		-98.50	(814)	
$C_{14}H_{26}O_3$	<i>l</i> -Menthylideneglycerol methyl ether*.....	80% EtOH	2.068	20	-21.2	(974)	
$C_{21}H_{40}O_2$	Di- <i>l</i> -menthylmethylal.....	EtOH	0.8	24	-77.94	(2137)	
	<i>Esters of menthol, allomenthol and carvomenthol</i>						
$C_{11}H_{21}NOS$	<i>l</i> -Menthyl xanthamide ($C_{10}H_{19}O.CS.NH_2$)..	PhMe	4.99		-115.9	(299)	
		C_6H_6	4.88		-120.78		
		EtOH	4.338		-113.17		
		AcOEt	4.89		-110.99		
		PhNMe ₂	4.91		-100.82		
$C_{11}H_{21}NO_2$	<i>l</i> -Menthyl carbamate ($C_{10}H_{19}O.CO.NH_2$)....	$CHCl_3$	0.58	21	-85.11	(50)	
$C_{12}H_{21}BrO_2$	<i>l</i> -Menthyl bromoacetate.....	$CHCl_3$	2.5	20	-63.20	(910)	
		$CHCl_3$	5	20	-62.64		
		MeOH	10.00	20	-78.00	(636)	
$C_{12}H_{21}ClO_2$	<i>l</i> -Menthyl chloroacetate.....		0.928	20	-27.6	(2063)	
$C_{12}H_{22}O_2$	Carvomenthyl acetate ($\lambda = 5780$).....		1.62		-32.9†	(227)	
$C_{13}H_{20}BrNO_2$	<i>l</i> -Menthyl bromocyanoacetate.....	C_6H_6	2.00		-81.15	(227)	
$C_{13}H_{21}NO_2$	<i>l</i> -Menthyl cyanoacetate.....		0.9917	11.5	-181.7	(343)	
$C_{13}H_{22}O_3$	<i>l</i> -Menthyl pyruvate.....	$CHCl_3$	2.5	20	-82.0		
		$CHCl_3$	5.0	20	-83.4		
		$CHCl_3$	2.5	20	-57.14	(1810)	
$C_{13}H_{23}BrO_2$	<i>l</i> -Menthyl α -bromopropionate.....	$CHCl_3$	5.0	20	-57.05		
		$CHCl_3$	2.0		-67.75	(908)	
$C_{14}H_{20}O_4$	<i>l</i> -Menthyl hydrogen acetylenedicarboxylate..	Me ₂ CO	2.0		-68.75		
		$CHCl_3$	2.0		-71.25	(908)	
$C_{14}H_{22}O_4$	<i>l</i> -Menthyl hydrogen fumarate.....	$CHCl_3$	2.0		-69.25		
		Me ₂ CO	2.0		-68.53	(1810)	
$C_{14}H_{24}O_2$	<i>l</i> -Menthyl trimethylenecarboxylate.....	EtOH	8.951	20	-90.67	(1810)	
$C_{14}H_{24}O_2$	<i>l</i> -Menthyl crotonate.....	C_6H_6	9.86	20	-91.06	(1821)	
			10.04	20	-91.76	(1821)	
$C_{14}H_{24}O_2$	<i>l</i> -Menthyl methacrylate.....	EtOH	9.54	20	-68.53	(1810)	
$C_{14}H_{24}O_2$	<i>l</i> -Menthyl trimethylenecarboxylate.....		1.5		-68.5	(1171)	
$C_{14}H_{24}O_3$	<i>l</i> -Menthyl acetoacetate (const.).....	EtOH	1.5		-59.8		
	(const.).....	AcOEt			-70.7†		
	(final).....	$CHCl_3$			-68.4†		
	(final).....	C_6H_6	2.5	20	-67.04	(908); cf. (346, 1811)	
$C_{14}H_{24}O_4$	<i>l</i> -Menthyl hydrogen succinate.....	Me ₂ CO	2.0		-65.5	(908)	
		$CHCl_3$	2.0		-66.0		
		$CHCl_3$	5		-64.00	(1630)	
		C_6H_6	1.4		-57.02		
$C_{14}H_{25}BrO_2$	<i>l</i> -Menthyl α -bromobutyrate.....	$CHCl_3$	2.5	20	-53.58	(293.5)	
		$CHCl_3$	5.0	20	-53.49		
$C_{14}H_{26}O_2$	<i>l</i> -Menthyl isobutyrate.....	C_6H_6	10.05	20	-72.05	(1821)	
		<i>l</i> -Menthyl butyrate.....	C_6H_6	9.99	20	-70.56	
					-69.52	(1810); cf. (294)	
$C_{14}H_{26}O_3$	<i>l</i> -Menthyl <i>dl</i> - α -hydroxybutyrate.....	EtOH	9.04		-72.91		
		<i>l</i> -Menthyl <i>dl</i> - β -hydroxybutyrate.....	EtOH	4.699	20	-70.4	(1347)
				0.9859	20	-62.7	
$C_{15}H_{26}O_2$	<i>l</i> -Menthyl tetramethylenecarboxylate.....	EtOH	5.082	20	-65.8		
$C_{15}H_{26}O_2$	<i>l</i> -Menthyl- $\Delta^{1,2}$ -pentenoate.....	EtOH	9.180	20	-69.09	(1810)	
	<i>l</i> -Menthyl- $\Delta^{2,3}$ -pentenoate.....	EtOH	9.250	20	-74.41	(1810)	
	<i>l</i> -Menthyl- $\Delta^{2,3}$ -pentenoate.....	EtOH	9.069	20	-72.51		
	<i>l</i> -Menthyl- $\Delta^{3,4}$ -pentenoate.....	EtOH	9.006	20	-67.32		
$C_{15}H_{26}O_2$	<i>l</i> -Menthyl tetramethylenecarboxylate.....	EtOH	9.18	20	-69.09	(1810)	
$C_{15}H_{26}O_2$	<i>l</i> -Menthyl α -methylerotenate.....	C_6H_6	9.89	20	-84.38	(1821)	
		<i>l</i> -Menthyl β -methylerotenate.....	C_6H_6	10.01	20	-88.60	

* $C_{10}H_{18}O$
 $\begin{array}{c} | \\ O-CH_1 \end{array} \begin{array}{c} \diagup \\ CH.CH_2.OCH_1. \end{array}$ † Mutarotation.

Esters of menthol, allomenthol and carvomenthol.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₅ H ₂₆ O ₃	<i>l</i> -Menthyl methylacetoacetate.....	C ₆ H ₆	9.88	20	−63.6	(1811)
C ₁₅ H ₂₆ O ₃	<i>l</i> -Menthyl levulinate.....	CHCl ₃	2.5	20	−67.6	(908)
		CHCl ₃	5.0	20	−67.62	
			0.9773 ₄ ^{19.6}	19.5	−60.6	(1327)
C ₁₅ H ₂₇ BrO ₂	<i>l</i> -Menthyl α -bromovalerate.....	CHCl ₃	2.5	20	−51.46	(293.5)
		CHCl ₃	5.0	20	−51.37	
C ₁₅ H ₂₇ N ₃ O ₃	<i>l</i> -Menthyl acetoacetate semicarbazide.....	CHCl ₃	1.5		−56.1	(1171)
C ₁₅ H ₂₆ O ₂	Propyl- <i>l</i> -menthyl acetate.....	C ₆ H ₆		22	−8.98	(158)
C ₁₅ H ₂₈ O ₂	<i>l</i> -Menthyl α -methylbutyrate.....	C ₆ H ₆	10.01	20	−63.97	(1821)
	<i>l</i> -Menthyl β -methylbutyrate.....	C ₆ H ₆	10.00	20	−64.02	
C ₁₅ H ₂₆ O ₂	<i>l</i> -Menthyl valerate.....				−65.55	(1810); cf. (294)
		EtOH	9.04		−69.5	
C ₁₅ H ₂₈ O ₃	<i>l</i> -Menthyl <i>dl</i> - α -ethoxypropionate.....		0.9363	20	−60.3	(1347)
		EtOH	4.66	20	−64.2	
C ₁₅ H ₂₄ O ₃ S	<i>l</i> -Menthyl benzenesulfonate.....	CHCl ₃	2.5	13	−73.20	(908)
		CHCl ₃	5.0	13	−72.68	
		EtOH	4.72	18.8	−73.02	(1578)
		C ₆ H ₆	5.38	19.2	−64.17	
		C ₆ H ₆	5.38	50.1	−61.53	
		PhNO ₂	18.77	16.0	−65.38	
		PhNO ₂	18.77	78.4	−58.94	
C ₁₆ H ₂₆ O ₂	<i>l</i> -Menthyl pentamethylenecarboxylate.....	EtOH	9.139	20	−67.94	(1810)
C ₁₆ H ₂₈ O ₃	<i>l</i> -Menthyl $\Delta^{1,2}$ -hexenoate.....	EtOH	9.032	20	−68.38	(1810)
	<i>l</i> -Menthyl $\Delta^{2,3}$ -hexenoate.....	EtOH	9.147	20	−65.11	
	<i>l</i> -Menthyl $\Delta^{3,4}$ -hexenoate.....	EtOH	9.711	20	−60.93	
	<i>l</i> -Menthyl $\Delta^{4,5}$ -hexenoate.....	EtOH	8.975	20	−61.25	
C ₁₆ H ₂₆ O ₃	<i>l</i> -Menthyl ethylacetoacetate.....	C ₆ H ₆	9.94	20	−60.3	(1811)
			0.9653	20	−63.0	(1327)
		EtOH	4.44	20.3	−67.9	
C ₁₆ H ₃₀ O ₂	<i>l</i> -Menthyl hexoate.....				−62.07	(1810); cf. (294)
		EtOH	9.02		−64.86	
C ₁₆ H ₂₉ BrO ₂	<i>l</i> -Menthyl α -bromohexoate.....	CHCl ₃	2.5	20	−48.06	(293.5)
		CHCl ₃	5.0	20	−48.49	
C ₁₇ H ₂₂ Cl ₂ O ₂	<i>l</i> -Menthyl 2, 3-dichlorobenzoate.....		1.1607	20	−52.57	(338)
	<i>l</i> -Menthyl 2, 4-dichlorobenzoate.....		1.1546	20	−63.72	
	<i>l</i> -Menthyl 2, 5-dichlorobenzoate.....		1.1590	20	−60.62	
	<i>l</i> -Menthyl 2, 6-dichlorobenzoate.....	CHCl ₃	6.36	20	−34.4	
	<i>l</i> -Menthyl 3, 4-dichlorobenzoate.....		1.1548	20	−69.16	
	<i>l</i> -Menthyl 3, 5-dichlorobenzoate.....		1.1535	20	−70.89	
C ₁₇ H ₂₂ BrClO ₂	<i>l</i> -Menthyl 2, 3-bromochlorobenzoate.....		1.2582 ₄ ²⁰	20	−46.18	(342)
	<i>l</i> -Menthyl 3, 2-bromochlorobenzoate.....		1.2372 ₄ ²⁰	20	−51.82	
	<i>l</i> -Menthyl 2, 4-bromochlorobenzoate.....		1.2683 ₄ ²⁰	20	−54.57	
	<i>l</i> -Menthyl 4, 2-bromochlorobenzoate.....		1.2723 ₄ ²⁰	20	−58.70	
	<i>l</i> -Menthyl 2, 5-bromochlorobenzoate.....		1.2764 ₄ ²⁰	20	−50.91	
	<i>l</i> -Menthyl 5, 2-bromochlorobenzoate.....		1.2677 ₄ ²⁰	20	−55.68	
	<i>l</i> -Menthyl 3, 4-bromochlorobenzoate.....		1.2866 ₄ ²⁰	20	−55.67	
	<i>l</i> -Menthyl 4, 3-bromochlorobenzoate.....		1.2854 ₄ ²⁰	20	−59.15	
	<i>l</i> -Menthyl 3, 5-bromochlorobenzoate.....		1.2444 ₄ ²⁰	20	−62.90	
C ₁₇ H ₂₂ Br ₂ O ₂	<i>l</i> -Menthyl 2, 3-dibromobenzoate.....		1.4189 ₄ ²⁰	20	−41.41	(345)
	<i>l</i> -Menthyl 2, 4-dibromobenzoate.....		1.4060 ₄ ²⁰	20	−51.62	
	<i>l</i> -Menthyl 2, 5-dibromobenzoate.....		1.3821 ₄ ²⁰	20	−50.95	
	<i>l</i> -Menthyl 2, 6-dibromobenzoate.....	C ₆ H ₆	15.64	20	−4.68	
	<i>l</i> -Menthyl 3, 4-dibromobenzoate.....		1.4258 ₄ ²⁰	20	−55.18	
	<i>l</i> -Menthyl 3, 5-dibromobenzoate.....		1.4114 ₄ ²⁰	20	−54.57	
C ₁₇ H ₂₂ N ₂ O ₆	<i>l</i> -Menthyl 2, 4-dinitrobenzoate.....	C ₆ H ₆	31.1	20	−130.8	(337)
		C ₆ H ₆	7.78	20	−137.2	
	<i>l</i> -Menthyl 2, 6-dinitrobenzoate.....	C ₆ H ₆	14.1	20	−183.4	
	<i>l</i> -Menthyl 3, 5-dinitrobenzoate.....	C ₆ H ₆	9.6	20	−70.1	
C ₁₇ H ₂₃ IO ₂	<i>l</i> -Menthyl <i>o</i> -iodobenzoate.....		1.375 ₂₀ ²⁰	20	−63.72	(342)
	<i>l</i> -Menthyl <i>m</i> -iodobenzoate.....		1.360 ₂₀ ²⁰	20	−60.75	
	<i>l</i> -Menthyl <i>p</i> -iodobenzoate.....		1.311 ₂₀ ²⁰	20	−62.48	

Esters of menthol, allomenthol and carvomenthol.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₇ H ₂₄ O ₂	<i>l</i> -Menthyl benzoate.....	CHCl ₃	2.5	13	−86.04	(908); <i>cf.</i> (50, 103, 105, 339)
		CHCl ₃	5.0	13	−85.60	
		CHCl ₃	5		−84.39	(1630)
		C ₆ H ₆	1		−90.59	
C ₁₇ H ₂₄ O ₂	Carvomenthyl benzoate ($\lambda = 5780$).....		1.006	20	−12.9	
C ₁₇ H ₂₅ NO ₂	<i>l</i> -Neomenthyl phenylcarbamate (C ₁₀ H ₁₉ O.CO.NH.C ₆ H ₅).....	CHCl ₃	5	?	−26.77	(1630)
C ₁₇ H ₂₆ O ₃ S	<i>l</i> -Menthyl <i>p</i> -toluenesulfonate.....	CHCl ₃	2.5	13	−66.80	(908.5)
		CHCl ₃	5.0	13	−66.76	
C ₁₇ H ₂₆ O ₂	<i>l</i> -Menthyl Δ^1 -tetrahydrobenzoate.....	EtOH	9.098	20	−74.64	(1810)
	<i>l</i> -Menthyl Δ^2 -tetrahydrobenzoate.....	EtOH	9.103	20	−59.44	
C ₁₇ H ₂₆ O ₃	<i>l</i> -Menthyl propylideneacetoacetate.....	C ₆ H ₆	1.59		−34.9	(825)
C ₁₇ H ₂₆ O ₃	<i>l</i> -Menthyl allylacetoacetate.....	C ₆ H ₆	10.03	20	−58.3	(1811)
C ₁₇ H ₃₀ O ₂	<i>l</i> -Menthyl $\Delta^{1,2}$ -heptenoate.....	EtOH	9.006	20	−66.03	(1810)
C ₁₇ H ₃₀ O ₂	<i>l</i> -Menthyl cyclohexanecarboxylate.....	EtOH	9.204	20	−59.11	(1810)
C ₁₇ H ₃₀ O ₃	<i>l</i> -Menthyl <i>n</i> -propylacetoacetate.....	C ₆ H ₆	10.03	20	−57.3	(1811)
C ₁₇ H ₃₂ O ₂	<i>l</i> -Menthyl heptoate.....				−58.85	(1810); <i>cf.</i> (294)
		EtOH	9.12		−61.94	
C ₁₈ H ₂₄ O ₃	<i>l</i> -Menthyl benzoylformate.....	EtOH	4.78	20	−44.4	(1326)
C ₁₈ H ₂₄ O ₄	<i>l</i> -Menthyl hydrogen phthalate.....	CHCl ₃	5.03		−90.67	(1630)
	<i>d</i> -Neomenthyl hydrogen phthalate.....	CHCl ₃	2.5		68.71	
C ₁₈ H ₂₅ ClO ₂	<i>l</i> -Menthyl <i>l</i> -phenylchloroacetate.....	EtOH	3.99	15	−149.8	(1346)
	<i>l</i> -Menthyl <i>d</i> -phenylchloroacetate.....	EtOH	4.37	14.5	5.7	
	<i>l</i> -Menthyl <i>d</i> -phenylchloroacetate ($\lambda = 5461$).....	EtOH	4.37	14.5	80	
	<i>l</i> -Menthyl <i>dl</i> -phenylchloroacetate.....	EtOH	3.92	16	−72.2	
	<i>l</i> -Menthyl <i>dl</i> -phenylchloroacetate ($\lambda = 5461$).....	EtOH	3.92	16	−85.9	
C ₁₈ H ₂₄ Br ₂ N ₂ O ₂	<i>l</i> -Menthyl bromomethylene- <i>p</i> -bromophenyl- hydrazoncarboxylate.....	C ₆ H ₆	1.60		−73.45	(1168)
C ₁₈ H ₂₄ BrClN ₂ O ₂	<i>l</i> -Menthyl bromomethylene- <i>p</i> -chlorophenyl- hydrazoncarboxylate.....	C ₆ H ₆	1.60		67.61	(1168)
C ₁₈ H ₂₅ BrN ₂ O ₂	<i>l</i> -Menthyl bromomethylenephénylhydra- zoncarboxylate (C ₆ H ₅ .NH.N: CBr.CO.OC ₁₀ H ₁₉).....	C ₆ H ₆	1.62		82.45	(1168)
C ₁₈ H ₂₆ O ₂	<i>l</i> -Menthyl phenylacetate.....		1.002	20	−68.70	(339)
			0.9400	100	−65.56	
C ₁₈ H ₂₆ O ₂	<i>l</i> -Menthyl <i>o</i> -toluate.....		0.9982	20	−84.35	(339)
			0.9383	100	−81.41	
	<i>l</i> -Menthyl <i>m</i> -toluate.....		0.9946	20	−87.59	
			0.9352	100	−85.63	
	<i>l</i> -Menthyl <i>p</i> -toluate.....		0.9937	20	−89.93	
			0.9336	100	−86.56	
		CHCl ₃	2.5	13	−95.36	
		CHCl ₃	5.0	13	−95.22	
C ₁₈ H ₂₆ O ₃	<i>l</i> -Menthyl <i>o</i> -methoxybenzoate.....		1.045	20	−51.08	(339)
			0.9823	100	−53.37	
	<i>l</i> -Menthyl <i>m</i> -methoxybenzoate.....		1.034	20	−85.39	
			0.9766	100	−83.69	
	<i>l</i> -Menthyl <i>p</i> -methoxybenzoate.....		1.036	20	−86.47	
			0.9766	100	−82.30	
C ₁₈ H ₂₆ O ₃	<i>l</i> -Menthyl <i>d</i> -mandelate.....	EtOH	3.60	20	−7.6	(1326)
	<i>l</i> -Menthyl <i>l</i> -mandelate.....	EtOH	4.37	20	−138.6	
C ₁₈ H ₃₀ O ₂	<i>l</i> -Menthyl 2, 4-dimethylsorbate.....	EtOH	9.77	20	−59.80	(1821)
C ₁₈ H ₃₂ O ₃	<i>l</i> -Menthyl diethylacetoacetate.....		0.9605	20	−54.8	(1327)
C ₁₈ H ₃₄ O ₂	<i>l</i> -Menthyl 2, 4-dimethylhexoate.....	C ₆ H ₆	9.84	20	−57.38	(1821)
C ₁₈ H ₃₄ O ₂	<i>l</i> -Menthyl octoate.....		0.8977	20	−55.25	(294)
C ₁₉ H ₂₄ O ₂	<i>l</i> -Menthyl phenylpropiolate.....	CHCl ₃	10	21	−58.65	(900)
		CHCl ₃	2.5	21	−60.20	
		Me ₂ CO	10	21	−55.55	
		Me ₂ CO	2.5	20	−52.40	
		C ₆ H ₆	9.84	20	−71.77	(1821)

Esters of menthol, allomenthol and carvomenthol.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₉ H ₂₄ BrN ₂ O ₂	<i>l</i> -Menthyl <i>p</i> -bromophenylazocanoacetate...	C ₆ H ₆	1.38		−42.75	(227)
C ₁₉ H ₂₅ NO ₆	2-Methyl 1- <i>l</i> -menthyl 3-nitrophthalate*....	C ₆ H ₆	3.2224		−122.9	(344)
	1-Methyl 2- <i>l</i> -menthyl 3-nitrophthalate*....	C ₆ H ₆	2.9340		−102.3	
	Methyl <i>l</i> -menthyl 4-nitrophthalate.....	C ₆ H ₆	2.2304		−61.6	
C ₁₉ H ₂₅ NO ₆	Methyl <i>l</i> -menthyl 2-nitroterephthalate.....		1.093	100	−92.41	(341.5)
		C ₆ H ₆	1.73	18	−141.5	
	Methyl <i>l</i> -menthyl 3-nitroterephthalate.....		1.133	20	68.31	
			1.096	100	62.19	
C ₁₉ H ₂₆ O ₂	<i>l</i> -Menthyl cinnamate.....	CHCl ₃	10	20	−60.00	(900)
		Me ₂ CO	10	20	−64.45	
		Me ₂ CO	2.5	20	−63.60	
C ₁₉ H ₂₆ O ₂	<i>l</i> -Menthyl atropate (α -phenylacrylate).....	C ₆ H ₆	10	20	−63.03	(1821)
			1.000 ¹⁰⁰	100	76.91	
C ₁₉ H ₂₆ O ₄	Methyl <i>l</i> -menthyl terephthalate.....		1.054 ²⁰	20	77.49	
C ₁₉ H ₂₇ BrN ₂ O ₂	<i>l</i> -Menthyl bromomethylene- <i>p</i> -tolylphenyl- hydrazoncarboxylate.....	C ₆ H ₆	1.62		86.95	(1168)
C ₁₉ H ₂₈ O ₂	<i>l</i> -Menthyl α -phenylpropionate.....	C ₆ H ₆	10.00	20	−61.87	(1821)
	<i>l</i> -Menthyl β -phenylpropionate.....	C ₆ H ₆	9.93	20	−58.48	(1821)
		CHCl ₃	10	20	−59.55	(900)
		CHCl ₃	2.5	20	−60.80	
		Me ₂ CO	10	20	−56.45	
		Me ₂ CO	2.5	20	−60.00	
C ₁₉ H ₂₈ O ₃	<i>l</i> -Menthyl <i>o</i> -ethoxybenzoate.....		0.9641	100	−51.75	(344)
	<i>l</i> -Menthyl <i>m</i> -ethoxybenzoate.....		1.017	20	−80.26	
			0.9582	100	−78.10	
	<i>l</i> -Menthyl <i>p</i> -ethoxybenzoate.....		0.9622	100	−78.39	
C ₁₉ H ₂₈ O ₃	<i>l</i> -Menthyl <i>d</i> - α -hydroxy- β -phenylpropionate..	C ₆ H ₆	1.40	17	−27.1	(1357)
		CHCl ₃	2.69	15.5	−36.9	
		Me ₂ CO	0.87		−49.4	
C ₁₉ H ₂₉ NO ₂	<i>l</i> -Menthyl <i>o</i> -dimethylaminobenzoate.....			100	−33.29	(344)
	<i>l</i> -Menthyl <i>p</i> -dimethylaminobenzoate.....			100	−85.13	
C ₂₀ H ₂₆ O ₃ S	<i>l</i> -Menthyl naphthalene- β -sulfonate.....	CHCl ₃	2.5	13	−57.12	(908.5)
		CHCl ₃	5.0	13	−56.50	
		EtOH	1.80	14.7	−56.86	(1578)
		C ₆ H ₆	1.02	18.3	−50.52	
		PhNO ₂	8.64	12.7	−41.20	
C ₂₀ H ₂₇ N ₃ O ₂	<i>l</i> -Menthyl <i>p</i> -tolylazocanoacetate.....	C ₆ H ₆	3.01		−53.7	(227)
C ₂₀ H ₂₇ ClN ₂ O ₃	<i>l</i> -Menthyl <i>p</i> -chlorophenylazoacetate.....	C ₆ H ₆	1.6		−55.79†	(1168)
C ₂₀ H ₂₇ BrN ₂ O ₃	<i>l</i> -Menthyl <i>p</i> -bromophenylazoacetate.....	C ₆ H ₆	1.60		−46.88†	(1168)
C ₂₀ H ₂₇ NO ₆	Ethyl <i>l</i> -menthyl 2-nitroterephthalate.....		1.410	20	−91.58	(341.5)
			1.08	100	−85.45	
		C ₆ H ₆	2.04	18	−130.5	
	Ethyl <i>l</i> -menthyl 3-nitroterephthalate.....		1.128	20	65.43	
			1.074	100	60.36	
C ₂₀ H ₂₇ NO ₆	2-Ethyl 1- <i>l</i> -menthyl 3-nitrophthalate*.....	C ₆ H ₆	2.3920		−125.4	(344)
	1-Ethyl 2- <i>l</i> -menthyl 3-nitrophthalate*.....	C ₆ H ₆	2.7906		−93.45	
C ₂₀ H ₂₈ N ₂ O ₄	<i>l</i> -Menthyl phenylazoacetate (initial)...	C ₆ H ₆	1.62		−52.5†	(1168)
C ₂₀ H ₂₈ O ₂	<i>l</i> -Menthyl α -methyleinnamate.....	C ₆ H ₆	9.95	20	−62.60	(344)
	<i>l</i> -Menthyl β -methyleinnamate.....	C ₆ H ₆	9.99	20	−65.89	
	<i>l</i> -Menthyl methylatropate (α -phenylcrotonate)	C ₆ H ₆	10.00	20	−46.13	
C ₂₀ H ₂₈ O ₃	<i>l</i> -Menthyl α -benzoylpropionate.....	EtOH	10.03	20	−57.7	(1811)
C ₂₀ H ₂₈ O ₃	<i>l</i> -Menthyl <i>o</i> -allyloxybenzoate.....		0.9689	100	−55.35	(339)
	<i>l</i> -Menthyl <i>p</i> -allyloxybenzoate.....		1.027	20	−79.69	
			0.9689	100	−74.95	
C ₂₀ H ₂₈ O ₄	Ethyl <i>l</i> -menthyl terephthalate.....		1.055	20	76.91	(341.5)
			0.995	100	72.43	
C ₂₀ H ₂₉ NO ₃	<i>l</i> -Menthyl β -phenylpropionylcarbamate.....	EtOH	1.00		−65.0	(610)
C ₂₀ H ₂₉ N ₃ O ₄	<i>l</i> -Menthyl acetoacetate <i>p</i> -nitrophenyl- hydrazide (NO ₂ .C ₆ H ₄ .N ₂ H ₂ .C(CH ₃):CH.CO.C ₁₀ H ₁₉)..	C ₆ H ₆	1.41		−42.5	(1171)
C ₂₀ H ₃₀ O ₂	<i>l</i> -Menthyl β -phenyl- α -methylpropionate....	C ₆ H ₆	10.04	20	−50.73	(1821)
C ₂₀ H ₃₀ O ₂	<i>l</i> -Menthyl α -phenylbutyrate.....	C ₆ H ₆	10.00	20	−26.78	

* The numbers, 1 and 2, refer to the carboxyl groups which carry the menthyl and alkyl radicals. † Mutarotation.

Esters of menthol, allomenthol and carvomenthol.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₂₁ H ₃₀ N ₂ O ₃	<i>l</i> -Menthyl <i>p</i> -tolylazoacetate.....	C ₆ H ₆	1.63		−61.6*	(1168)
C ₂₀ H ₃₀ O ₂	<i>l</i> -Menthyl <i>γ</i> -phenylbutyrate.....	C ₆ H ₆ ?	10.02	20	−57.0	(1811)
C ₂₀ H ₃₀ O ₂	<i>l</i> -Menthyl <i>l</i> -β-phenylbutyrate.....	C ₆ H ₆	9.86	20	−76.26	(1821)
C ₂₀ H ₃₀ O ₃	<i>l</i> -Menthyl <i>o</i> -propoxybenzoate.....		1.019	20	−53.5	(339)
			0.9589	100	−56.63	
	<i>l</i> -Menthyl <i>m</i> -propoxybenzoate.....		1.010	20	−75.65	
			0.9511	100	−73.93	
	<i>l</i> -Menthyl <i>p</i> -propoxybenzoate.....		1.016	20	−78.66	
			0.9569	100	−73.60	
C ₂₀ H ₃₀ O ₃	<i>l</i> -Menthyl <i>o</i> -isopropoxybenzoate.....		1.034	20	−53.08	
			0.9766	100	−56.54	
	<i>l</i> -Menthyl <i>p</i> -isopropoxybenzoate.....		1.011	20	−77.42	
			0.9514	100	−73.37	
C ₂₀ H ₃₀ O ₃	<i>l</i> -Menthyl <i>dl</i> -phenylethoxyacetate.....		1.0007	20	−65.65	(1347)
		EtOH	4.320	20	−68.4	
C ₂₀ H ₃₄ O ₄	Allo- <i>l</i> -menthyl hydrogen camphorate.....	C ₆ H ₆	1.022	20	−26.45	(344)
C ₂₁ H ₂₆ O ₂	<i>l</i> -Menthyl α-naphthoate.....	EtOH	9.09	20	−79.08	(1810)
	<i>l</i> -Menthyl β-naphthoate.....	C ₆ H ₆	9.97	20	−91.3	(181.05)
		CHCl ₃	2.5	13	−91.12	
		CHCl ₃	5.0	13	−90.60	
C ₂₁ H ₂₈ O ₂	<i>l</i> -Menthyl Δ ¹ -dihydro-α-naphthoate.....	EtOH	9.13	20	−69.12	(1810)
	<i>l</i> -Menthyl Δ ² -dihydro-α-naphthoate.....	AcOEt	9.92	20	92.85	
		EtOH	4.12	20	89.60	
	<i>l</i> -Menthyl Δ ² -dihydro-β-naphthoate.....	EtOH	9.98	20	−41.40	(1810.5)
	<i>l</i> -Menthyl Δ ³ -dihydro-β-naphthoate.....	EtOH	9.96	20	−53.14	
C ₂₁ H ₂₈ O ₂	<i>l</i> -Menthyl cinnamylacrylate.....	C ₆ H ₆	9.98	20	−75.14	(1821)
C ₂₁ H ₂₈ O ₃	<i>l</i> -Menthyl benzylideneacetate.....	C ₆ H ₆	9.96	20	−11.2	(1811)
C ₂₁ H ₂₉ NO ₆	Propyl <i>l</i> -menthyl 2-nitroterephthalate.....		1.118	20	−91.12	(341.5)
			1.059	100	−87.12	
		C ₆ H ₆	2.41	18	−129.7	
	Propyl <i>l</i> -menthyl 3-nitroterephthalate.....		1.130	20	62.25	(341.5)
			1.060	100	58.73	
C ₂₁ H ₂₉ NO ₆	2-Propyl <i>l</i> -1-menthyl 3-nitrophthalate*.....	C ₆ H ₆	2.2228		−116.9	(344)
	1-Propyl <i>l</i> -2-menthyl 3-nitrophthalate*.....	C ₆ H ₆	2.5184		−83.4	
C ₂₁ H ₃₀ O ₂	<i>l</i> -Menthyl tetrahydro-α-naphthoate.....	EtOH	9.11	20	−47.57	(1810.5)
		EtOH	9.106	20	−47.57	(1810)
	<i>l</i> -Menthyl tetrahydro-β-naphthoate.....	EtOH	9.89	20	−53.04	
		CHCl ₃	9.86	20	−53.04	(1810.5)
C ₂₁ H ₃₀ O ₂	<i>l</i> -Menthyl 4-phenyl-Δ ^{2,3} -pentoate.....	C ₆ H ₆	10.03	20	−47.54	(1821)
C ₂₁ H ₃₀ O ₃	<i>l</i> -Menthyl α-benzoylbutyrate.....	EtOH	9.92	20	−55.9	(1811)
		C ₆ H ₆	9.98	20	−54.3	
C ₂₁ H ₃₀ O ₄	<i>l</i> -Menthyl propyl phthalate.....		1.0447	20	64.49	(344)
C ₂₁ H ₃₀ O ₄	<i>l</i> -Menthyl propyl terephthalate.....		1.041	20	73.79	(341.5)
			0.9845	100	69.69	
C ₂₁ H ₃₁ NO ₂	<i>l</i> -Menthyl β-benzylaminoerotonate.....	C ₆ H ₆	1.61		−59.8	
C ₂₁ H ₃₂ O ₂	<i>l</i> -Menthyl δ-phenylvalerate.....	C ₆ H ₆	10.03	20	−33.86	(1821)
C ₂₁ H ₃₆ O ₄	Orthomethyl allomenthyl camphorate.....		1.020	20	−20.1	(344)
			0.9656	100	−21.1	
	Allomethyl orthomenthyl camphorate.....		1.021	20	−25	
			0.9629	100	−26.3	
C ₂₁ H ₃₃ O ₃	Di- <i>l</i> -menthyl carbonate.....	C ₆ H ₆	2.021	21	−92.52	(50)
C ₂₁ H ₃₉ NO ₂	<i>l</i> -Menthyl <i>l</i> -menthylcarbamate (C ₁₀ H ₁₉ O.CO.NH.C ₁₀ H ₁₉).....	EtOH	2.55	?	−91.03	(1630)
C ₂₂ H ₂₈ O ₃	<i>l</i> -Menthyl α-methoxynaphthoate.....		1.076	20	−78.27	(339)
			1.022	100	−70.32	
	<i>l</i> -Menthyl β-methoxynaphthoate.....		1.083	20	−48.94	
			1.025	100	−46.84	
C ₂₂ H ₂₈ O ₄	<i>l</i> -Menthyl piperate.....	CHCl ₃	2.5	15.3	−52.76	(905)
		CHCl ₃	5.0	15.3	−53.02	
C ₂₂ H ₃₀ O ₃	<i>l</i> -Menthyl α-benzoyl-Δ ³ -pentoate.....	C ₆ H ₆	9.99	20	−51.4	(1811)
C ₂₂ H ₃₀ O ₄	<i>l</i> -Menthyl β, γ-hydropiperate.....	CHCl ₃	2.5	15.3	−46.08	(905)
		CHCl ₃	5.0	15.3	−45.92	
	<i>l</i> -Menthyl α, β-hydropiperate.....	CHCl ₃	2.5	15.3	−42.12	
		CHCl ₃	5.0	15.3	−42.22	

* The numbers, 1 and 2, refer to the carboxyl groups which carry the menthyl and alkyl radicals.

Esters of menthol, allomenthol and carvomenthol.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₂₂ H ₃₀ O ₆	<i>l</i> -Menthyl piperonylbutyrate.....	CHCl ₃	2.5	15.3	−38.00	(905)
		CHCl ₃	5.0	15.3	−39.68	
C ₂₂ H ₃₁ NO ₆	2-Isobutyl 1- <i>l</i> -menthyl 3-nitrophthalate*....	C ₆ H ₆	2.1396		−115	(344)
	1-Isobutyl 2- <i>l</i> -menthyl 3-nitrophthalate*....	C ₆ H ₆	2.3868		−79.2	
C ₂₂ H ₃₁ NO ₆	<i>n</i> -Butyl <i>l</i> -menthyl 2-nitroterephthalate.....		1.098	20	−90.49	(341.5)
			1.041	100	−84.53	
		C ₆ H ₆	2.02	18	−124.7	
	<i>n</i> -Butyl <i>l</i> -menthyl 3-nitroterephthalate.....		1.136	20	60.23	
			1.057	100	57.53	
C ₂₂ H ₃₂ O ₃	<i>l</i> -Menthyl α -benzoylvalerate.....	EtOH	10.00	20	−52.3	(1811)
C ₂₂ H ₃₂ O ₃	<i>l</i> -Menthyl β -phenylethylacetate.....	C ₆ H ₆	9.97	20	−51.6	(1811)
		EtOH	10.05	20	−53.8	
C ₂₂ H ₃₂ O ₄	<i>l</i> -Menthyl isobutyl phthalate.....		1.0338	20	−63.96	(344)
C ₂₂ H ₃₂ O ₄	<i>n</i> -Butyl <i>l</i> -menthyl terephthalate.....		1.037	20	71.48	(341.5)
			0.9848	100	66.91	
	Isobutyl <i>l</i> -menthyl terephthalate.....		1.044	20	73.91	
			0.988	100	69.92	
C ₂₂ H ₃₄ O ₃	<i>l</i> -Menthyl <i>o</i> -isoamyloxybenzoate.....		1.003	20	−54.01	(339)
			0.9442	100	−56.69	
	<i>l</i> -Menthyl <i>m</i> -isoamyloxybenzoate.....		0.9947	20	−69.53	
			0.9363	100	−68.66	
	<i>l</i> -Menthyl <i>p</i> -isoamyloxybenzoate.....		0.9954	20	−71.57	
			0.9400	100	−67.57	
C ₂₂ H ₄₀ O ₃	<i>l</i> -Menthyl <i>sec</i> .-octylacetate.....	C ₆ H ₆	10.00	20	−47.8	(1811)
C ₂₃ H ₃₂ O ₃	<i>l</i> -Menthyl cinnamylacetate.....	C ₆ H ₆	9.98	20	−41.3	(1811)
C ₂₃ H ₃₄ O ₃	<i>l</i> -Menthyl γ -phenylpropylacetate.....	C ₆ H ₆	10.00	20	−45.4	(1811)
		EtOH	9.98	20	−49.0	
C ₂₃ H ₃₄ O ₄	<i>l</i> -Menthyl isoamyl phthalate.....		1.0215	20	55.9	(344)
C ₂₃ H ₄₀ O ₄	Di- <i>l</i> -menthyl malonate.....	CHCl ₃	2.5	15	−79.54	(906)
		CHCl ₃	5.0	15	−79.24	
C ₂₄ H ₃₄ O ₄	Cyclohexyl <i>l</i> -menthyl terephthalate.....		1.036	20	67.69	(341.5)
			1.006	100	62.03	
C ₂₄ H ₃₀ O ₂	<i>l</i> -Menthyl diphenylacetate.....	C ₆ H ₆	10.0	20	−66.70	(1821)
C ₂₄ H ₃₀ O ₃	<i>l</i> -Menthyl <i>o</i> -benzyloxybenzoate.....		1.142	20	−47.07	(339)
			1.083	100	−44.49	
	<i>l</i> -Menthyl <i>p</i> -benzyloxybenzoate.....		1.064	20	−69.68	
			1.0015	100	−65.29	
C ₂₄ H ₃₆ O ₄	Hexyl <i>l</i> -menthyl phthalate.....		1.0179	20	−60.26	(344)
C ₂₄ H ₃₈ O ₄	Di- <i>l</i> -menthyl acetylenedicarboxylate.....	CHCl ₃	2.5		−84.2	(908)
		Me ₂ CO	2.5		−85.6	
C ₂₄ H ₄₀ O ₄	Di- <i>l</i> -menthyl fumarate.....	CHCl ₃	2.5		−100.6	(908)
		Me ₂ CO	2.5		−99.4	
C ₂₄ H ₄₂ O ₄	Di- <i>l</i> -menthyl succinate.....	CHCl ₃	2.5	15	−82.40	(906); <i>cf.</i> (50)
		CHCl ₃	5.0	15	−81.90	
		Me ₂ CO	2.5		−81.4	
C ₂₄ H ₄₂ O ₆	Di- <i>l</i> -menthyl <i>l</i> -tartrate.....		1.0450	16.3	−76.11	(1579.5)
			0.9547	134.9	−84.22	
		EtOH	2.42	20	−76.06	
		EtOH	7.054	20	−75.60	
		C ₆ H ₆	5.394	20	−74.94	
		PhNO ₂	5.348	20	−89.32	
C ₂₄ H ₄₆ O ₂	<i>l</i> -Menthyl myristate.....	CHCl ₃	2.5	20	−42.74	(910)
		CHCl ₃	5.0	20	−42.83	
		EtOH	2.5	20	−43.86	
		EtOH	5.0	20	−43.41	
C ₂₄ H ₄₆ BrO ₂	<i>l</i> -Menthyl α -bromomyristate.....	CHCl ₃	2.5	20	−36.44	(293.5)
C ₂₆ H ₂₉ NO ₆	<i>l</i> -Menthyl α -benzyl 3-nitrophthalate.....	C ₆ H ₆	2.59	18.5	−83.0	(344)
C ₂₅ H ₃₀ O ₂	<i>l</i> -Menthyl α -phenylcinnamate.....	C ₆ H ₆	9.76	20	−53.44	(1821)
	<i>l</i> -Menthyl β -phenylcinnamate.....	C ₆ H ₆	9.92	20	−37.92	
C ₂₅ H ₃₂ O ₂	<i>l</i> -Menthyl α , β -diphenylpropionate.....	C ₆ H ₆	9.96	20	−86.04	(1821)
	<i>l</i> -Menthyl β , β -diphenylpropionate.....	C ₆ H ₆	9.94	20	−61.72	

* The numbers, 1 and 2, refer to the carboxyl groups which carry the menthyl and alkyl radicals.

Esters of menthol, allomenthol and carvomenthol.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₂₅ H ₄₂ O ₄	<i>l</i> -Menthyl mesaconate.....		0.9904	17.6	−91.05	(343)
C ₂₅ H ₄₄ O ₄	Di- <i>l</i> -menthyl glutarate.....	CHCl ₃	2.5	15	−80.16	(906)
		CHCl ₃	5.0	15	−80.26	
C ₂₅ H ₄₄ O ₄	<i>l</i> -Menthyl pyrotartrate.....		0.978	11.8	−71.6	(343)
C ₂₆ H ₃₀ O ₃	<i>l</i> -Menthyl α-benzoylcinnamate.....	C ₆ H ₆	9.75	20	−77.4	(1811)
C ₂₆ H ₃₀ O ₄	<i>l</i> -Menthyl dibenzoylacetate.....	C ₆ H ₆	10	20	−64.07	(1833)
C ₂₆ H ₃₂ O ₂	<i>l</i> -Menthyl α-benzylcinnamate.....	C ₆ H ₆	9.64	20	−144.9	(1811)
C ₂₆ H ₃₂ O ₃	<i>l</i> -Menthyl α-benzoyl-β-phenylpropionate....	C ₆ H ₆	10.03	20	−60.8	(1811)
C ₂₆ H ₃₄ O ₂	<i>l</i> -Menthyl dibenzylacetate.....	C ₆ H ₆	9.64	20	−24.4	(1811)
C ₂₆ H ₄₀ O ₄	<i>l</i> -Menthyl octyl phthalate.....		1.0095	20	61.4	(344)
C ₂₆ H ₄₀ O ₄	Octyl <i>l</i> -menthyl terephthalate.....		0.999	20	59.25	
			0.946	100	55.99	
C ₂₆ H ₄₂ O ₄	Di- <i>l</i> -menthyl muconate.....	CHCl ₃	2.5	15.3	−93.40	(905)
C ₂₆ H ₄₄ O ₄	Di- <i>l</i> -menthyl β, γ-hydromuconate.....	CHCl ₃	2.5	15.3	−88.78	(905)
		CHCl ₃	5.0	15.3	−88.80	
	Di- <i>l</i> -menthyl α, β-hydromuconate.....	CHCl ₃	2.5	15.3	−80.78	
		CHCl ₃	5.0	15.3	−81.52	
C ₂₆ H ₄₆ O ₄	Di- <i>l</i> -menthyl adipate.....	CHCl ₃	2.5	15.3	−83.60	(905); cf. (906)
		CHCl ₃	5.0	15.3	−83.80	
C ₂₆ H ₄₈ BrO ₂	<i>l</i> -Menthyl α-bromopalmitate.....	CHCl ₃	2.5	20	−33.98	(910)
		CHCl ₃	5.0	20	−34.34	
C ₂₆ H ₅₀ O ₂	<i>l</i> -Menthyl palmitate.....	CHCl ₃	2.5	20	−39.34	(293.5)
		CHCl ₃	5.0	20	−39.79	
		EtOH	2.5	20	−40.54	
		EtOH	5.0	20	−40.17	
C ₂₇ H ₃₄ O ₃	<i>l</i> -Menthyl α-benzoyl-γ-phenylbutyrate.....	C ₆ H ₆	9.95	20	−56.7	(1811)
C ₂₇ H ₄₈ O ₄	Di- <i>l</i> -menthyl pimelate.....	CHCl ₃	2.5	15	−77.82	(906)
		CHCl ₃	5.0	15	−78.31	
C ₂₈ H ₃₂ O ₃	<i>l</i> -Menthyl β-benzyloxynaphthoate.....			20	−87.27	(339)
				100	−77.82	
C ₂₈ H ₃₄ O ₃	<i>l</i> -Menthyl <i>l</i> -α-benzoyl-δ-phenyl-Δ ³ -penteno- ate.....	C ₆ H ₆	9.97	20	−86.7	(1811)
	<i>l</i> -Menthyl <i>d</i> -α-benzoyl-δ-phenyl-Δ ³ -penteno- ate.....	C ₆ H ₆	9.95	20	−25.9	(1811)
C ₂₈ H ₃₆ O ₃	<i>l</i> -Menthyl α-benzoyl-δ-phenylvalerate.....	C ₆ H ₆	9.98	20	−44.0	(1811)
C ₂₈ H ₄₂ O ₄	Di- <i>l</i> -menthyl phthalate.....	C ₆ H ₆	2.006	20	−94.72	(50)
C ₂₈ H ₄₂ O ₄	Di- <i>l</i> -menthyl terephthalate.....	CHCl ₃	9.96	20	−102.64	(1810.5)
C ₂₈ H ₄₄ O ₄	Di- <i>l</i> -menthyl Δ ^{1,4} -dihydroterephthalate....	CHCl ₃	10	20	−104.55	(1810.5)
C ₂₈ H ₄₆ O ₄	Di- <i>l</i> -menthyl Δ ¹ -tetrahydroterephthalate....	CHCl ₃	10	20	−69.42	(1810.5)
	Di- <i>l</i> -menthyl Δ ² -tetrahydroterephthalate....	CHCl ₃	10.03	20	−76.09	
C ₂₈ H ₄₆ O ₈	Di- <i>l</i> -menthyl diacetyl- <i>l</i> -tartrate.....		1.0550	16	−70.28	(1579.5)
			0.9477	150	−77.54	
		EtOH	5.801	20	−71.77	
		C ₆ H ₆	5.219	20	−61.37	
		PhNO ₂	5.357	20	−69.54	
C ₂₈ H ₄₆ O ₆	<i>l</i> -Menthyl diacetyl- <i>dl</i> -tartrate.....		0.9540	145.6	−55.52	(1580)
			0.9683	130	−55.29	
		EtOH	0.455	20	−57.3	
		C ₆ H ₆	5.20	17.2	−48.12	
		C ₆ H ₆	5.20	37.7	−50.79	
		C ₆ H ₆	5.20	20	−48.59	
		PhNO ₂	4.38	17.2	−47.73	
		PhNO ₂	4.38	37.4	−49.88	
	<i>l</i> -Menthyl diacetyl- <i>d</i> -tartrate.....		0.9970	97.2	−44.63	
			0.9668	134.4	−41.96	
C ₂₈ H ₄₈ O ₄	Di- <i>l</i> -menthyl <i>trans</i> -hexahydroterephthalate..	CHCl ₃	10.16	20	−74.72	(1810.5)
C ₂₈ H ₅₀ O ₄	Di- <i>l</i> -menthyl suberate.....	CHCl ₃	2.5	15	−73.28	(906)
		CHCl ₃	5.0	15	−73.56	
C ₂₈ H ₅₄ O ₂	<i>l</i> -Menthyl stearate.....	CHCl ₃	2.5	20	−36.94	(910)
		CHCl ₃	5.0	20	−36.71	
		EtOH	2.5	20	−37.70	
		EtOH	5.0	20	−37.73	

Esters of menthol, allomenthol and carvomenthol.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₂₉ H ₅₂ O ₄	Di- <i>l</i> -menthyl azelate.....	CHCl ₃	2.5	15	−72.32	(906)
		CHCl ₃	5.0	15	−72.68	
C ₃₀ H ₅₀ O ₆	Di- <i>l</i> -menthyl ethylidene- <i>bis</i> -acetoacetate....	C ₆ H ₆	1.60		−26.5*	(825)
C ₃₀ H ₅₄ O ₄	Di- <i>l</i> -menthyl sebacate.....	CHCl ₃	2.5	15	−66.72	(906)
		CHCl ₃	5.0	15	−67.08	
C ₃₁ H ₅₂ O ₆	Di- <i>l</i> -menthyl propylidene- <i>bis</i> -acetoacetate...	C ₆ H ₆	0.521		−26.9	(825)
C ₃₂ H ₅₄ O ₆	Di- <i>l</i> -menthyl <i>n</i> -butylidene- <i>bis</i> -acetoacetate..	C ₆ H ₆	0.742		−16.8	(825)
	Di- <i>l</i> -menthyl isobutylidene- <i>bis</i> -acetoacetate..	C ₆ H ₆	1.17		−46.0*	
C ₃₅ H ₅₂ O ₆	Di- <i>l</i> -menthyl benzylidene- <i>bis</i> -acetoacetate...	C ₆ H ₆	0.575		−30.4	(825)
C ₃₆ H ₅₃ NO ₆	<i>l</i> -Trimenthyl nitrilotriacetate (N(CH ₂ .CO.OCC ₁₀ H ₁₉) ₃).....		1.0027	19	−39.47	(653)
			0.9917	36.2	−38.78	
			0.9773	58.4	−38.03	
			0.9637	79.4	−37.39	
			0.9515	98.0	−36.81	
		MeOH	0.9183	20	−88.22	
		MeOH	1.443	20	−88.03	
		MeOH	2.190	20	−87.89	

Homologues of menthol and their esters

C ₁₁ H ₂₂ O	Methylmenthol.....	C ₆ H ₆		21	−2.43	(158)
C ₁₂ H ₂₄ O	Ethylmenthol.....	C ₆ H ₆		22	4.91	(158)
C ₁₃ H ₂₄ O ₂	Methylmenthyl acetate.....	C ₆ H ₆		22	−18.11	(158)
C ₁₃ H ₂₆ O	<i>n</i> -Propylmenthol.....	C ₆ H ₆		22	29.7	(158)
C ₁₄ H ₂₆ O ₂	Ethylmenthyl acetate.....	C ₆ H ₆		21	−6.6	(158)
C ₁₅ H ₂₈ O ₂	Propylmenthyl acetate.....	C ₆ H ₆		22	−8.98	(158)
C ₁₅ H ₃₀ O	Isoamylmenthol.....	C ₆ H ₆		22	33.73	(158)
C ₁₇ H ₂₆ O	Benzylmenthol.....	C ₆ H ₆		20	−43.19	(158)
C ₁₉ H ₂₆ O ₄	Methylmenthyl phthalate.....			20	83.62	(344)

POLYHYDRIC ALCOHOLS

C ₁₅ H ₁₆ O ₂	<i>l</i> - α , β -Dihydroxy- α , β -diphenylpropane.....	Me ₂ CO	1.648	12.5	34.0	(1355)
C ₁₆ H ₁₈ O ₂	<i>l</i> - α , β -Dihydroxy- α , β -diphenylbutane (C ₂ H ₅ .C(C ₆ H ₅)OH.CH(C ₆ H ₅)OH).....	EtOH	2.883	12.5	19.6	(1355)
		CHCl ₃	2.044	10.5	3.2	
		Me ₂ CO	4.674	11.7	27.4	

KETONES

C ₇ H ₁₂ O ₂	1-Methylcyclohexanol-3-one.....		1.0399 ¹⁹ ₄		21.6	(2237)
C ₇ H ₁₁ BrO	Bromo-1, 3-methylcyclohexanone.....	PhMe			−47.9	(2237)

CARBOXYLIC ACIDS

HYDROXY ACIDS (INCLUDING THOSE DERIVED FROM MENTHOL AND THEIR ESTERS)

C ₈ H ₁₄ O ₃	<i>d</i> -1-Methylcyclohexan-3-ol-4-carboxylic acid†	EtOH	0.409	17	−31.8	(709)
C ₁₀ H ₁₀ O ₃	<i>d</i> - β -Phenyl- β -methylglycidic acid‡.....	H ₂ O	3.0		16.6	(2212)
C ₁₀ H ₁₈ O ₃	Ethyl <i>d</i> -1-methylcyclohexan-3-ol-4-carboxylate.....	AcOEt	5.11		5.9	(288)
C ₁₁ H ₂₀ O ₃	<i>d</i> -Isomentholcarboxylic acid.....	EtOH	0.4990		12.0	(709)
C ₁₂ H ₂₀ O ₂	Pulegolacetic anhydride§ (isomeride a).....	EtOH	3.17	20	18.21	(2078)
	(isomeride b).....	EtOH	2.86	20	21.65	(2078)
C ₁₂ H ₂₂ O ₃	Menthoxycetic acid (C ₁₀ H ₁₉ O.CH ₂ .COOH).....	MeOH	4.22	20	−92.93	(652)
C ₁₅ H ₂₆ O ₃	Allyl menthoxycetate.....		0.9720	14	−93.15	(652)
			0.9640	25	91.51	
C ₁₅ H ₂₇ NO ₂	Menthoxycetic allylamide.....		0.9667	20	−76.11	(652)
C ₁₅ H ₂₇ NO ₂	Menthyl allylaminoacetate.....		0.9488	20.5	−63.43	(652)
C ₁₅ H ₂₈ O ₃	Propyl menthoxycetate.....		0.9547	20	91.46	(652)
C ₁₅ H ₂₉ NO ₂	Menthoxycetic propylamide.....		0.9545	20	−75.97	(652)
C ₁₅ H ₂₉ NO ₂	Menthyl propylaminoacetate.....		0.9330	20.0	−62.08	(652)

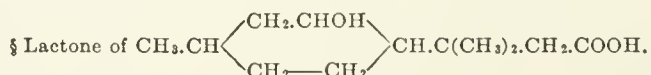
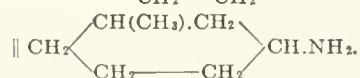
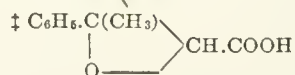
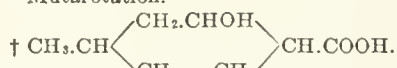
AMINES

MONOAMINES

Monoamines excluding menthylamine

C ₇ H ₁₅ N	1, 3-Methylcyclohexylamine 		0.8456	20	−1.9	(767)
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* Mutarotation.

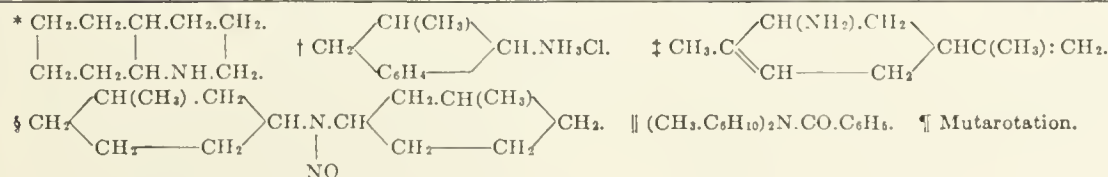


Monoamines excluding menthylamine.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _{<i>D</i>}	Lit.
C ₉ H ₁₇ N	<i>d</i> -Decahydroquinoline*	EtOH			4.81	(1398)
	<i>l</i> -Decahydroquinoline*	EtOH			−4.5	
C ₁₀ H ₁₄ ClN	<i>l</i> -Methylhydrindamine hydrochloride†	H ₂ O	1.81		−30.3	(2007)
C ₁₀ H ₁₇ N	Carvylamine‡		0.9168 ₁₉	19	105.8	(831)
C ₁₄ H ₂₆ N ₂ O	Nitroso- α -di-(3-methylcyclohexyl)amine§	Et ₂ O	11.11	20	−34	(2116)
C ₂₁ H ₃₁ NO	Benzoyl- α -dimethylcyclohexylamine	Et ₂ O	6.90		−34.65	(2116)
	Benzoyl- β -dimethylcyclohexylamine	EtOH	7.85		−11.88	
C ₂₆ H ₃₁ BrNO ₄ S	Benzylhydrindamine bromocamphor-sulfonate (α)	EtOH	1.00		50	(1076)
		CHCl ₃	0.80		41.6	
	Benzylhydrindamine bromocamphor-sulfonate (β)	EtOH	1.00		51.5	
		CHCl ₃	1.60		42.8	

Menthylamine, its salts and acyl derivatives

C ₁₀ H ₂₁ N	<i>l</i> -Menthylamine		0.860	7	−38.07	(145, 2126)
C ₁₀ H ₂₂ BrN	<i>d</i> -Menthylamine hydrobromide	EtOH	11.27		−31.90	(145)
		H ₂ O	1.30	14	13.83	(145)
		Et ₂ O	1.36	12.5	5.26	
C ₁₀ H ₂₂ ClN	<i>l</i> -Menthylamine hydrochloride	H ₂ O	0.8	15	−36.4	(1663)
		H ₂ O	2.77	15	17.24	(145)
		Et ₂ O	1.71	9	8.34	
C ₁₀ H ₂₂ IN	<i>d</i> -Menthylamine hydroiodide	H ₂ O	2.75	14.5	11.79	(145)
C ₁₁ H ₂₁ NO	Formyl- <i>l</i> -menthylamine	AcOEt	2.19	10.5	−76.44	(145)
		CHCl ₃	5.25	6	−83.78	
		MeOH	7.44	10	−83.43	
		AcOEt	1.83	12	50.89	(145)
C ₁₁ H ₂₁ NO	Formyl- <i>d</i> -menthylamine	CHCl ₃	5.39	4	54.11	
		MeOH	7.16	11	63.30	
		CHCl ₃	4.6		54.33	(1395)
		AcOEt	2.16	13	−76.27	(145)
C ₁₂ H ₂₃ NO	Acetyl- <i>l</i> -menthylamine	CHCl ₃	5.36	10	−81.73	
		MeOH	7.38	10	−85.67	
		CHCl ₃	4.9		−78.83	(1395)
		AcOEt	1.77	13	44.71	(145)
C ₁₂ H ₂₃ NO	Acetyl- <i>d</i> -menthylamine	CHCl ₃	4.40	5	50.57	
		MeOH	5.39	10	48.80	
		CHCl ₃	5.09	5	−76.53	
		AcOEt	2.13	13	−67.26	(145)
C ₁₃ H ₂₅ NO	Propionyl- <i>l</i> -menthylamine	CHCl ₃	8.93	8	−78.02	
		EtOH	2.6	9	−76.02	
		CHCl ₃	5.51	8	45.14	
		AcOEt	1.84	12	40.45	(145)
C ₁₃ H ₂₅ NO	Propionyl- <i>d</i> -menthylamine	CHCl ₃	7.19	9	54.30	
		MeOH	2.22	12	−63.58	(145)
		CHCl ₃	4.47	4	−72.10	
		AcOEt	1.78	13.5	35.64	(145)
C ₂₄ H ₄₈ N ₂ O ₆	Di- <i>l</i> -menthylamine <i>d</i> -tartrate	CHCl ₃	4.88	6	40.59	
		MeOH	1.31	22.6	−12.58	(1586)
		MeOH	1.31	20.7	−42.00	
		MeOH	1.31	22	−32.07	
C ₄₆ H ₈₈ FeN ₁₀	<i>l</i> -Menthylammonium α -ferrocyanide	EtOH	1.080	17	−42.4	(247)
		0.016% EtOH?	1.002	17	−34.2¶	
		AcOH?	1.044	17	−31.8¶	
		EtOH	1.000	17	−28.5	

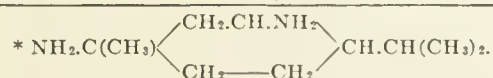


N-Menthyl carbamates: $C_{10}H_{19}.NH.COOR$

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
$C_{11}H_{21}NO_2$	<i>l</i> -Menthyl carbamate.....	EtOH	0.8		−81.6	(610)
$C_{12}H_{23}NO_2$	Methyl <i>l</i> -menthylcarbamate..... ($C_{10}H_{19}.NH.CO.OCH_3$)	CHCl ₃	3.13	16	−74.29	(1514)
		MeOH	2.79	16	−76.11	
		CHCl ₃	7.86	21	−77.67	(1631)
$C_{13}H_{25}NO_2$	Ethyl <i>l</i> -menthylcarbamate..... ($C_{10}H_{19}.NH.CO.OC_2H_5$)	CHCl ₃	2.05	21	−69.43	(1514)
		EtOH	2.34		−67.39	
		CHCl ₃	7.67	21	−71.98	(1631)
$C_{14}H_{26}NO_2$	Allyl <i>l</i> -menthylcarbamate.....	CHCl ₃	8.02	21	−68.24	(1631)
$C_{14}H_{27}NO_2$	Propyl <i>l</i> -menthylcarbamate.....	CHCl ₃	2.36	21	−68.56	(1631)
		CHCl ₃	1.95	21	−65.77	
$C_{15}H_{29}NO_2$	<i>n</i> -Butyl <i>l</i> -menthylcarbamate.....	CHCl ₃	4.53	21	−64.85	(1631)
		CHCl ₃	1.87	21	−66.28	
$C_{17}H_{25}NO_2$	Phenyl <i>l</i> -menthylcarbamate.....	CHCl ₃	5.23	19	−57.83	(1628)
$C_{18}H_{27}NO_2$	Benzyl <i>l</i> -menthylcarbamate.....	CHCl ₃	7.55	21	−52.80	(1631)
		Py	5.20	19	−67.41	
$C_{18}H_{27}NO_2$	<i>o</i> -Tolyl <i>l</i> -menthylcarbamate.....	CHCl ₃	4.07	19	−54.74	(1628)
		Py	4.17	19	−64.48	
	<i>m</i> -Tolyl <i>l</i> -menthylcarbamate.....	CHCl ₃	4.72	19	−55.86	
		Py	5.70	19	−66.17	
$C_{18}H_{27}NO_2$	<i>p</i> -Tolyl <i>l</i> -menthylcarbamate.....	CHCl ₃	3.42	19	−56.28	
		Py	3.74	19	−64.82	
	<i>n</i> -Heptyl <i>l</i> -menthylcarbamate.....	CHCl ₃	6.78	21	−55.18	(1631)
	1, 3, 4-Xylyl <i>l</i> -menthylcarbamate.....	CHCl ₃	3.02	19	−53.45	(1628)
$C_{19}H_{29}NO_2$	1, 2, 4-Xylyl <i>l</i> -menthylcarbamate.....	Py	3.94	19	−63.16	
		CHCl ₃	3.58	19	−51.38	
	1, 2, 5-Xylyl <i>l</i> -menthylcarbamate.....	Py	2.79	19	−61.84	
		CHCl ₃	2.18	19	−51.3	
$C_{19}H_{29}NO_2$	Phenylethyl <i>l</i> -menthylcarbamate.....	CHCl ₃	4.66	21	−56.06	(1631)
$C_{19}H_{37}NO_2$	<i>n</i> -Octyl <i>l</i> -menthylcarbamate.....	CHCl ₃	9.1	21	−52.10	(1631)
$C_{20}H_{29}NO_2$	Cinnamyl <i>l</i> -menthylcarbamate.....	CHCl ₃	4.42	21	−49.62	(1631)
$C_{20}H_{31}NO_2$	Phenylpropyl <i>l</i> -menthylcarbamate.....	CHCl ₃	3.43	21	−48.14	(1631)
$C_{21}H_{27}NO_2$	1-Naphthyl <i>l</i> -menthylcarbamate.....	CHCl ₃	4.52	19	−51.52	(1628)
		Py	4.99	19	−63.45	
	2-Naphthyl <i>l</i> -menthylcarbamate.....	CHCl ₃	4.25	19	−48.15	
		Py	5.20	19	−59.90	
$C_{21}H_{33}NO_2$	Carvacryl <i>l</i> -menthylcarbamate.....	CHCl ₃	3.14	19	−46.64	(1628)
		Py	3.12	19	−57.58	
$C_{21}H_{33}NO_2$	Thymyl <i>l</i> -menthylcarbamate.....	CHCl ₃	5.20	19	−45.48	(1628)
		Py	4.72	19	−56.29	
$C_{21}H_{37}NO_2$	<i>l</i> -Bornyl <i>l</i> -menthylcarbamate.....	EtOH	3.4		−71.04	(1629)
	<i>dl</i> -Isobornyl <i>l</i> -menthylcarbamate.....	EtOH	5		−55.8	(1629)
	<i>d</i> -Isobornyl <i>l</i> -menthylcarbamate.....	EtOH	2.67		1.41	
	<i>l</i> -Isobornyl <i>l</i> -menthylcarbamate.....	EtOH	2.64		−112.0	
$C_{27}H_{53}NO_2$	Cetyl <i>l</i> -menthylcarbamate.....	CHCl ₃	4.88	21	−36.90	(1631)
<i>Menthylcarbimide and carbamides: C₁₀H₁₉N:CO and C₁₀H₁₉.NH.CO.NH.R or C₁₀H₁₉.NH.CO.NR₁R₂</i>						
$C_{11}H_{19}NO$	<i>l</i> -Menthylcarbimide ($C_{10}H_{19}.N:CO$).....	C ₆ H ₆	2.22		−54.97	(1514)
$C_{13}H_{26}N_2O$	Ethyl- <i>l</i> -menthylcarbamide.....	EtOH	24.5		−53.83	
		CHCl ₃	3.09	19	−69.16	(1620)
		Py	2.87	19	−70.23	
$C_{14}H_{28}N_2O$	<i>n</i> -Propyl- <i>l</i> -menthylcarbamide.....	EtOH	3.12	19	−73.77	
		CHCl ₃	3.07	19	−66.03	(1628)
	Isopropyl- <i>l</i> -menthylcarbamide.....	Py	3.19	19	−66.88	
		EtOH	3.09	19	−70.08	
$C_{14}H_{26}N_2O$	Allyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	3.32	19	−64.76	
		Py	3.14	19	−65.22	
		EtOH	3.12	19	−67.42	
$C_{14}H_{26}N_2O$	\	CHCl ₃	3.25	19	−65.33	(1628)
		Py	3.26	19	−68.05	
		EtOH	3.10	19	−70.11	
$C_{16}H_{30}N_2O$	Diethyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	3.23	19	−78.66	(1628)
		Py	3.09	19	−74.56	
		EtOH	3.19	19	−75.25	

Menthylcarbimide and carbamides: $C_{10}H_{19}N:CO$ and $C_{10}H_{19}.NH.CO.NH.R$ or $C_{10}H_{19}.NH.CO.NR_1R_2$.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _{<i>D</i>}	Lit.	
C ₁₅ H ₃₀ N ₂ O	<i>n</i> -Butyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	3.08	19	−62.55	(1628)	
		Py	3.03	19	−64.19		
		EtOH	3.05	19	−66.39		
	Isobutyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	2.78	19	−63.51		
		Py	3.14	19	−65.22		
		EtOH	3.08	19	−66.76		
	<i>tert.</i> -Butyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	1.24	19	−67.72	(1628)	
		Py	1.23	19	−66.21		
		EtOH	3.50	19	−64.77		
	C ₁₆ H ₃₀ N ₂ O	Piperidyl <i>l</i> -menthylcarbamide..... (C ₁₀ H ₁₉ .NH.CO.N.C ₅ H ₁₀)	CHCl ₃	2.0	19	−81.17	(1628)
			Py	1.91	19	−78.18	
			EtOH	2.67	19	−86.42	
C ₁₈ H ₂₈ N ₂ O	Benzyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	2.04	19	−51.47	(1628)	
		Py	1.96	19	−59.26		
		EtOH	2.15	19	−56.80		
C ₁₈ H ₂₈ N ₂ O	<i>o</i> -Tolyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	1.67	19	−56.14	(1628)	
		Py	2.40	19	−76.29		
		EtOH	2.65	19	−65.98		
	<i>m</i> -Tolyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	1.31	19	−68.15		
		Py	2.20	19	−81.59		
		EtOH	1.11	19	−75.51		
	<i>p</i> -Tolyl- <i>l</i> -menthylcarbamide.....	CHCl ₃	0.991	19	−66.06		
		Py	2.82	19	−81.15		
		EtOH	2.86	19	−85.23		
	C ₂₁ H ₂₈ N ₂ O	1-Naphthyl- <i>l</i> -menthylcarbamide.....	Py	1.06	19	−70.31	(1628)
		2-Naphthyl- <i>l</i> -menthylcarbamide.....	Py	1.66	19	−78.56	
			EtOH	1.51	19	−71.09	
C ₂₁ H ₄₀ N ₂ O	Di- <i>l</i> -menthylcarbamide..... (CO(NH.C ₁₀ H ₁₉) ₂)	EtOH	1.65		−91.75	(1514)	
		Py	1.83		−92.76		
		Menthylbenzamidines: C ₁₀ H ₁₉ .N:C $\begin{matrix} \nearrow C_6H_5 \\ \searrow NHR \end{matrix}$ or C ₁₀ H ₁₉ .N:C $\begin{matrix} \nearrow C_6H_5 \\ \searrow NR_1R_2 \end{matrix}$					
C ₁₉ H ₃₀ N ₂	<i>l</i> -Menthylethylbenzamidine.....	CHCl ₃	2.505	12	−112	(340)	
C ₂₁ H ₃₄ N ₂	<i>l</i> -Menthyl-diethylbenzamidine.....	CHCl ₃	1.9024	14	−172	(340)	
C ₂₃ H ₃₀ N ₂	Phenyl- <i>l</i> -menthylbenzamidine.....	CHCl ₃	2.5360	12.5	−146	(340)	
C ₂₄ H ₃₂ N ₂	<i>o</i> -Tolylmenthylbenzamidine.....	CHCl ₃	2.5056	14	−105	(340)	
	<i>m</i> -Tolyl- <i>l</i> -menthylbenzamidine.....	CHCl ₃	2.477	14	−142.5		
	<i>p</i> -Tolyl- <i>l</i> -menthylbenzamidine.....	CHCl ₃	2.496	14	−132.5		
	Phenyl- <i>l</i> -menthylethylbenzamidine.....	CHCl ₃	1.4384	12	−392		
C ₂₆ H ₃₄ N ₂		CHCl ₃	2.504	12	−391	(340)	
		CHCl ₃	2.9744	16	−60.5		
		CHCl ₃					
DIAMINES							
C ₁₀ H ₂₄ Cl ₂ N ₂	Aminotetrahydroumbellulylamine*						
	dihydrochloride.....	EtOH	1.63		−21.41	(2046)	
C ₂₄ H ₂₈ N ₂ O ₂	Dibenzoylaminotetrahydroumbellulylamine.	CHCl ₃	2.15		117.3	(2046)	
C ₂₄ H ₃₂ N ₂ O ₄	Aminotetrahydroumbellulylamine						
	dibenzoate.....	EtOH	1.69		−8.83	(2046)	
AMINO ACIDS							
<i>Ecgonine</i> = <i>Tropinecarboxylic acid</i> ; for <i>pilosine</i> , see <i>pilocarpine</i> , p. 420							
C ₇ H ₁₁ NO ₃	Ecgoninic acid.....	H ₂ O	12.37		−43.2	(1245.5)	
C ₉ H ₁₄ ClNO ₂	Anhydroecgonine hydrochloride.....	H ₂ O			−61.5	(416.5); cf. (892)	
C ₉ H ₁₄ Br ₃ NO ₂	Anhydroecgonine dibromide hydrobromide..	H ₂ O	3.06		30	(703)	
C ₉ H ₁₆ Br ₂ NO ₂	Hydrobromoanhydroecgonine hydrobromide	H ₂ O	1.25		42.3	(703)	
C ₉ H ₁₆ ClNO ₃	<i>d</i> -Ecgonine hydrochloride.....	H ₂ O	4.4		18.2	(417)	
		H ₂ O			−57		
C ₁₀ H ₁₇ NO ₃	<i>d</i> -Ecgonine methyl ester.....	EtOH	6.22		22.5	(1247)	
C ₁₀ H ₁₉ NO ₄ .H ₂ O	Ecgonine methohydroxide.....	H ₂ O	4.45	15	−42.4	(894)	
C ₁₁ H ₁₇ NO ₂	Anhydroecgonine ethyl ester.....		1.064 ²¹	19	−48.4	(1246)	
C ₁₆ H ₂₆ ClNO ₄	Isovaleryl- <i>d</i> -ecgonine methyl ester hydrochloride.....					(374)	
		EtOH	2.01		25.4		

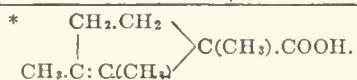


Ecgonine = Tropinecarboxylic acid; for pilosine, see pilocarpine, p. 420.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₉ H ₂₄ ClNO ₄	Cinnamyl- <i>d</i> -ecgonine methyl ester hydrochloride.....	EtOH	2.11		47.4	(374)
C ₂₀ H ₂₇ NO ₄	Benzoyl- <i>l</i> -ecgonine methyl ester.....	CHCl ₃	9.925	20	-16.35	(39)
		CHCl ₃	20.242	20	-16.28	
C ₂₀ H ₂₈ ClNO ₄	Benzoyl- <i>l</i> -ecgonine methyl ester hydrochloride.....		10	20	-66.399	(39)
C ₂₀ H ₂₈ ClNO ₄	Benzoyl- <i>d</i> -ecgonine butyl ester hydrochloride.....	H ₂ O	2.5		46	(417.5)
C ₂₁ H ₃₀ ClNO ₄	Benzoyl- <i>d</i> -ecgonine amyl ester hydrochloride.....	H ₂ O	2.2		38.6	(417.5)
<i>Cocaine = Methylbenzoylecgonine</i>						
C ₁₇ H ₂₁ NO ₄	Cocaine (free base).....	50% EtOH	1.088		-35.4	(268); cf. (1945)
		CHCl ₃	4.0		-15.75	
	(neutralized with dil. HCl).....	H ₂ O	0.3569		-78.5	
	(neutralized with H ₂ SO ₄).....	H ₂ O	1.088		-81.8	
	(neutralized with H ₂ SO ₄).....	50% EtOH	1.088		-77.7	
C ₁₇ H ₂₂ ClNO ₄	Cocaine hydrochloride.....	CHCl ₃	2.0		-57.5	(268)
C ₁₇ H ₂₂ ClNO ₄	Benzoyl- <i>d</i> -ecgonine methyl ester hydrochloride.....	EtOH	1.9		39.47	(417)
C ₁₇ H ₂₂ ClNO ₄	Cocaine hydrochloride.....	H ₂ O	2	17	70.82	(957)
		H ₂ O	5	17	-69.83	
		H ₂ O	10	17	-67.80	
		H ₂ O	15	17	-65.77	
		H ₂ O	20	17	-64.00	
C ₁₈ H ₂₃ NO ₆	Cocaine formate.....	H ₂ O	1	20	-54.67	(2071)
C ₁₈ H ₂₄ ClNO ₄	Benzoyl- <i>d</i> -ecgonine ethyl ester hydrochloride	H ₂ O	2		40	(417)
C ₁₉ H ₂₆ ClNO ₄	Benzoyl- <i>d</i> -ecgonine propyl ester hydrochloride.....	H ₂ O	2.6		46.2	(417)
<i>Hydrastine</i>						
C ₂₁ H ₂₁ NO ₆	Hydrastine.....	50% EtOH	0.204		115.0	(268)
		85% EtOH	0.2		37.5	
		93% EtOH	0.2		30.0	
		95% EtOH	0.4		0.0	
		97% EtOH	0.4		-12.5	
		100% EtOH	0.291		-49.8	
		CHCl ₃	2.552	17	-57.8	(676)
		2 <i>N</i> HCl	4.050	17	-127.3	
		50% Me ₂ CO	0.2		100.0	(268)
		Me ₂ CO	4.0		-85.0	
		CHCl ₃	2.0		-63.8	
C ₂₁ H ₂₂ ClNO ₆	Hydrastine hydrochloride.....	H ₂ O	1.647		197.0	(268)
		CHCl ₃	2.0		8.52	
<i>Hyoscyamine = Isomer of atropine</i>						
C ₁₇ H ₂₃ NO ₃	<i>l</i> -Hyoscyamine ion neut. by					
	(a) H ₂ SO ₄ (dil.).....		4.015		32.6	(268)
	(b) H ₂ SO ₃ (dil.).....		4.009		32.4	
	(c) HCl (dil.).....		4.0		32.4	
	(d) AcOH (dil.).....		4.0		32.5	
		50% EtOH	4.0		21.0	(268)
	Neut. by H ₂ SO ₄ (dil.).....		4.0		31.25	
C ₁₇ H ₂₃ NO ₃	<i>l</i> -Hyoscyamine	CHCl ₃	4.0		-23.75	(268); cf. (31, 90)
		50% EtOH	4.0		-22.06	
		50% EtOH	20.0		-22.0	

IID. The Molecule Contains an Asymmetric Atom Forming Part of a Ring and Attached to Four Other Carbon Atoms
ACIDS

C ₉ H ₁₄ O ₂	γ-Launolic acid.....	1.0177 ₂₀ ²⁰	20	145	(2026); cf. (224.5)
C ₉ H ₁₄ O ₂	Launolic acid*.....	1.0133 ₄ ²⁵	25	187.7	(1516)

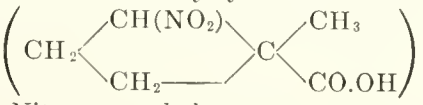


ACIDS.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₉ H ₁₄ O ₃	Camphononic acid*.....	C ₆ H ₆	2.4	27.5	17.8	(1519)
		EtOH	3.0	28	-3.9	
C ₉ H ₁₆ NO	Lauronolic amide.....	ligroin	1	25	94.6	(1516)
C ₁₁ H ₂₀ O ₃	Ethyl hydroxylauronate.....		1.100 ₄ ²⁰	33.5	6.73	(1520)
C ₁₀ H ₁₅ N	β-Fencholenic nitrile.....		0.9203 _{15.6} ^{15.6}	15.6	43.66	(334.5)
C ₁₀ H ₁₆ O ₂	β-Fencholenic acid†.....	EtOH			19.64	(1922)

IIDB. The Molecule Contains Two or More Asymmetric Atoms Attached Respectively to Two and Four Other Carbon Atoms

ACIDS

C ₆ H ₉ NO ₄	2-Nitro-1-methylcyclobutanecarboxylic acid. 	EtOH(?)		25	-87.31	(1692)
C ₉ H ₁₃ NO ₄	Nitrosocampholactone.....	EtOH	5.5		-85.4	(1521)
C ₉ H ₁₄ O ₂	cis-Camphonololactone†.....	EtOH	10	26	22.3	(1512)
C ₉ H ₁₄ O ₂	Isocampholactone.....	EtOH	8.8	28	-63.1	(1519)
C ₉ H ₁₄ O ₂	Campholytolactone.....	EtOH	12		8.5	(1527)
C ₉ H ₁₆ O ₃	cis-Camphonolic acid.....	EtOH	10	28	29.2	(1519)
C ₉ H ₁₆ O ₃	l-trans-3-Hydroxy-1, 5, 5 trimethylcyclopentane-1-carboxylic acid§.....	EtOH	3.29	27	-10.3	(1956)

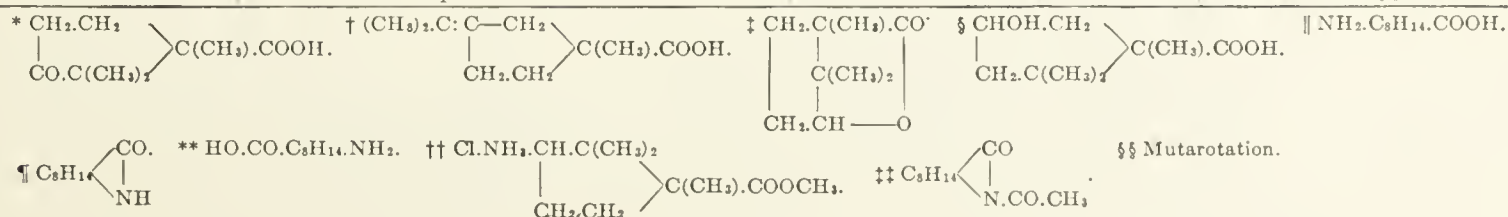
AMINO ACIDS

C ₉ H ₁₄ N ₂ O ₂	Nitrosoaminocamphoranic anhydride.....	EtOH	2.5	24	153	(1528)
C ₉ H ₁₆ NO	Aminocamphonanic anhydride¶.....	EtOH	10	29	-60.5	(1528)
		H ₂ O	0.5	28	-60.6	
C ₉ H ₁₇ ClNO ₂	Aminolauronic acid hydrochloride.....	H ₂ O	1.437	18	26.1	(2159)
		EtOH	1.335	18	26.6	
C ₉ H ₁₇ NO	Aminodihydrocampholytic acid 	ligroin	10.0	30	72.8	(1527)
C ₉ H ₁₇ NO ₂	Aminocamphonanic acid**.....	H ₂ O	10	25	-29.2	(1528)
C ₁₀ H ₂₀ NClO ₂	Methyl d-cis-3-amino-1, 2, 2-trimethylcyclopentanoate hydrochloride††.....	H ₂ O	4.0		20.4	(1956)
		EtOH	10		29.2	
C ₁₁ H ₁₇ NO ₂	Acetylaminocamphonanic anhydride‡‡.....	EtOH	10.88		72.7	(1528)
C ₁₁ H ₁₇ NO ₃	n-Anhydrocarboxymethylaminolauronic acid	H ₂ O	1.465	14	-22.2	(2159)
		EtOH	1.503	14	-11.6	
		C ₆ H ₆	1.239	14	-22.2	
C ₁₁ H ₁₉ NO ₄	Carboxymethylaminolauronic acid.....	H ₂ O	1.445	18	45.7	(2159)
C ₁₆ H ₁₉ NO ₂	n-Anhydrobenzoylaminolauronic acid.....	EtOH	1.476	18	-69.1	(2159)
C ₁₆ H ₂₁ NO ₃	Benzoylaminolauronic acid.....	EtOH	1.115	20	-18.4	(2159)
C ₁₇ H ₂₃ NO ₄	Methyl benzoylaminolauronate.....	EtOH	1.453	19	-28.9	(2159)
		H ₂ O		19	-18.4	(2159.5)

IIDC. The Molecule Contains Two or More Asymmetric Atoms Attached Respectively to Three and Four Other Carbon Atoms

HYDROCARBONS AND THEIR HALOGEN AND NITROGEN DERIVATIVES

C ₁₀ H ₁₃ Br ₂ NO ₃	1, 2-Dibromo-1-nitrocamphane.....	C ₆ H ₆	1.98	19	4.2	(578)
C ₁₀ H ₁₆ NO ₂	1-Nitrocamphene.....	EtOH	2.02	21	112.0	(578)
		C ₆ H ₆	4.00	21	137.5	
C ₁₀ H ₁₆	Camphene.....	C ₆ H ₆	16.38	20	62.59	(257)
C ₁₀ H ₁₆	Bornylene.....	C ₆ H ₆	8.98	20	-22.27	(849)
C ₁₀ H ₁₆ BrNO ₂	1, 1-Bromonitrocamphane.....	EtOH	2.0		-53.8	(577)
C ₁₀ H ₁₆ BrNO ₂	2-Bromo-1-nitrocamphane.....	C ₆ H ₆	2.04	21	3.7	(578)
C ₁₀ H ₁₆ Cl ₂	1, 1-Dichlorocamphane.....	AcOEt	22.34		-16	(1979)
C ₁₀ H ₁₆ ClNO ₂	1, 1-Chloronitrocamphane.....	EtOH	2.04	21	-53.1	(577)
		C ₆ H ₆	2.04	21	71.9	
C ₁₀ H ₁₆ INO ₂	1, 1-Iodonitrocamphane.....	EtOH	1.0	19	-10.8	(577)
		C ₆ H ₆	2.0	20	-15.0	
C ₁₀ H ₁₆ INO ₂	2-Iodo-1-nitrocamphane.....	EtOH	1.42	20	-35.1	(578)
		C ₆ H ₆	1.47	20	-29.4	
C ₁₀ H ₁₇ NO ₂	1-Nitrocamphane.....	EtOH	2.404	20	4.6	(577)
		C ₆ H ₆	2.0	20	20.4	
	Pseudonitrocamphane.....	KOH.EtOH	2.2		4§§	



HYDROCARBONS AND THEIR HALOGEN AND NITROGEN DERIVATIVES.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₀ H ₁₈	Isocamphane (from camphene).....		0.846 ¹⁹	17	0	(959)
	(from borneol).....	EtOH	8.76	17	−8.5	
	(from isoborneol).....	EtOH	8.51	17	2.81	
	(from camphor).....	EtOH	4.688		−3.95	
C ₁₀ H ₁₈	Thujane ((1) from <i>l</i> -α-thujene).....		0.8139	20	62.03	(311)
	((2) from <i>d</i> -β-thujene).....		0.8191	20	34.72	
	((3) from sabinene).....		0.819	20	18.6	
C ₁₁ H ₁₆ N ₂ O	<i>d</i> -Limonene α-nitrosocyanide.....	CHCl ₃	2.27	18.5	152.7	(1179)
	<i>d</i> -Limonene β-nitrosocyanide.....	CHCl ₃	1.87	19	−31.6	
C ₁₁ H ₁₈	Homofenchene.....	Et ₂ O	41.9	17	23.06	(2131)
C ₁₇ H ₂₁ NO ₃	Benzoyl-ψ-nitrocamphane.....	EtOH	2.0	21	−19.3	(577)
C ₂₀ H ₃₄	Hydrodifenchene.....		0.9652 ¹⁷	18	1.14	(1124)

ALCOHOLS

MONOHYDRIC ALCOHOLS OTHER THAN BORNEOL

For thujol, see p. 454

C ₁₀ H ₁₆ O	α-Hydroxycamphene.....	EtOH	4.02	19	34.1	(578)
		C ₆ H ₆	2.12	20	29.5	
C ₁₀ H ₁₆ O	Teresantalol.....	EtOH			11.97	(1925)
C ₁₀ H ₂₀ O	α, β, β, γ-Tetramethylcyclopentane-α-carbinol.....	C ₆ H ₆		20	67.18	(1818, 1832)
C ₁₂ H ₂₀ O	β, β-Dimethylnorcamphane-γ-spirocyclopropanemethylol.....	EtOH	1.496	20	26.79	(257)
C ₁₂ H ₂₂ O	Ethylcamphol.....	EtOH			37.0	(813)

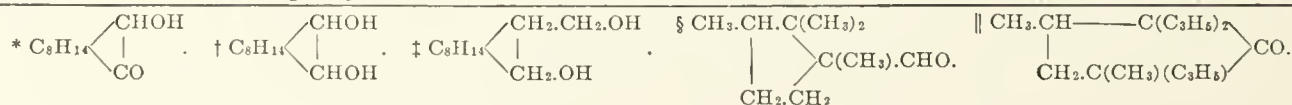
DIHYDRIC ALCOHOLS AND OTHER DIHYDROXY COMPOUNDS

C ₁₀ H ₁₆ O ₂	<i>l</i> -Campherol (hydroxycamphor)*.....	EtOH	3.34		−32.93	(1357.5)
C ₁₀ H ₁₈ O ₂	α, β-Camphorglycol†.....	EtOH	9.97		12.3	(1368)
C ₁₁ H ₂₂ O ₂	Homocamphoriglycol‡.....	EtOH	5.55	21	81.08	(1553)
C ₁₂ H ₂₂ O ₂	α, β-Dimethylcamphanediol.....	EtOH	1.22		0.95	(587)
C ₁₃ H ₂₂ O ₂	9-Methyl-3-isopropenyldicyclononan-5, 7-diol (solid).....	EtOH	7.88	19	−19.35	(1758)
	(liquid).....	EtOH	7.42	15	11.75	
C ₁₅ H ₂₆ O ₄	Homocamphoriglycol diacetate.....	EtOH	13.4	21	52.6	(1553)
C ₂₅ H ₃₀ O ₄	Homocamphoriglycol dibenzoate.....	EtOH	9.23	21	34.68	(1553)

ALDEHYDES AND KETONES

ALDEHYDES AND KETONES NOT RELATED DIRECTLY TO TERPENES

C ₁₀ H ₁₈ O	1, 2, 2, 3-Tetramethylcyclopentane-1-aldehyde§.....	C ₆ H ₆		20	89.26	(1832, 1835)
C ₁₁ H ₂₀ O	1, 2, 2, 3-Tetramethylcyclopentane-1-methyl ketone.....			20	63.67	(1818, 1832)
C ₁₂ H ₂₂ O	1, 2, 2, 3-Tetramethylcyclopentane-1-ethyl ketone.....			20	63.15	(1818, 1832)
C ₁₃ H ₂₀ O ₂	9-Methyl-3-isopropenyldicyclononan-5-ol-7-one.....	EtOH	7.07	15	18.8	(1758)
C ₁₆ H ₂₂ O	1, 2, 2, 3-Tetramethylcyclopentane-1-phenyl ketone.....			20	−1.21	(1818, 1832)
C ₁₆ H ₂₄ O	β, α'-Dimethyl-α, α'-triallylcyclopentanone 		0.9179	20	73.11	(808)
C ₁₆ H ₃₀ O	α, β-Dimethyl-α, α'-tripropylcyclopentanone.....			17	7.10	(809)
C ₁₇ H ₂₄ O	1, 2, 2, 3-Tetramethylcyclopentane-1-benzyl ketone.....			20	32.16	(1832)
C ₁₈ H ₂₄ O	1, 2, 2, 3-Tetramethylcyclopentane-cinnamyl ketone.....			20	54.29	(1832)
C ₁₈ H ₂₆ O	1, 2, 2, 3-Tetramethylcyclopentane-1, 2-phenylethyl ketone.....			20	18.96	(1832)
C ₂₀ H ₂₄ O	1, 2, 2, 3-Tetramethylcyclopentane-1, 1-naphthyl ketone.....	C ₆ H ₆	10	20	−60.52	(1832)



FENCHONE AND DERIVATIVES

Formula	Name	Solvent	d, C or %	$t, ^\circ C$	$[\alpha]_D$	Lit.
$C_{10}H_{14}O_2$	Diketofenchane.....	C_6H_6	14.2	15.5	75.78	(233)
$C_{10}H_{15}BrO$	Bromofenchone.....		1.348 ₁₂ ¹²	12	8.61	(360)
$C_{10}H_{15}BrO$	Bromoisofenchone.....	EtOH	2.42	15	-164.1	(2130)
$C_{10}H_{16}O$	<i>d</i> -Fenchone*.....		0.9442 ₄ ²⁰	17	63.01	(1858); <i>cf.</i> (58)
	<i>l</i> -Fenchone.....		0.9402 ₄ ²⁰	15.5	-51.24	
$C_{10}H_{17}N$	Fenchoneimine.....		0.9322 _{11.5} ^{11.5}	19.5	76.30	(1359)
$C_{10}H_{17}NO$	Fenchone oxime.....	EtOH	1.14	10	65.94	(2108)
		AcOEt	2.72	14.5	52.61	(145)
$C_{11}H_{19}N_3O$	<i>l</i> -Fenchone semicarbazone.....	MeOH	8.11	20	47.04	(2131)
$C_{11}H_{19}N_3O$	Isofenchone semicarbazone.....	MeOH	1.25	11	-8.27	(2130)

THUJONE AND DERIVATIVES

$C_{10}H_{16}O$	α -Thujone†.....		0.9190 ¹⁵		-29.90	(726); <i>cf.</i> (1918)
	β -Thujone; <i>cf.</i> (306, 2114).....		0.924	12	67.4	(2022); <i>cf.</i> (306, 2114)
$C_{10}H_{17}NO$	β -Thujoneoxime.....	MeOH	19.90	11	105.1	(1131)
$C_{11}H_{15}O$	Methylthujone.....		0.9102	15	16.27	(796)
$C_{11}H_{19}N_3O$	α -Thujone semicarbazone.....	MeOH	4.99	22	59.83	(1131)
	β -Thujone semicarbazone.....	MeOH	6.29	21	223.67	
$C_{12}H_{20}O$	Dimethylthujone.....		0.916	15	-19.45	(801)
$C_{12}H_{20}O$	Ethylthujone.....		0.9155	15	-48.37	(801)
$C_{13}H_{20}O$	Allylthujone.....		0.9254	15	-57.78	(297)
$C_{13}H_{22}O$	Propylthujone.....		0.9102	15	-48.47	(297)
$C_{18}H_{20}O_3$	Piperonylidenethujone.....	EtOH	2.36	15	-765	(297)
$C_{18}H_{22}O_2$	Anisylidenethujone.....	EtOH	2.89	15	-829.00	(297)

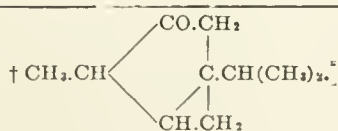
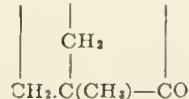
EPICAMPHOR AND DERIVATIVES

$C_{10}H_{15}BrO$	Bromo- <i>l</i> -epicamphor.....	AcOEt	3.62	19	-86.6	(237)
$C_{10}H_{15}NO_2$	α -Isonitrosoepicamphor.....	C_6H_6	4.00	19	-201.9	(237)
	β -Isonitrosoepicamphor.....	C_6H_6	5.10	19	-183.5	
	α -Isonitrosoepicamphor.....	$CHCl_3$	1.020		196.1†	(608); <i>cf.</i> (236)
	β -Isonitrosoepicamphor.....	$CHCl_3$	1.045		191.4†	
$C_{10}H_{15}NO_2$	Isonitrosoepicamphor (stable).....	$CHCl_3$	1.0	170	-200.1	(589)
		2% NaOH	1.0	170	-422.0	
	(unstable).....	$CHCl_3$	1.0	137	-179.0	
		2% NaOH	1.0	137	288.0	
$C_{10}H_{16}O$	<i>l</i> -Epicamphor§.....	C_6H_6	13.12	19	-58.21	(237)
$C_{10}H_{17}NO$	<i>l</i> -Epicamphoroxime.....	C_6H_6	6.29	19	100.8	(237)
$C_{11}H_{17}NO_2$	α -Isonitrosoepicamphor- <i>o</i> -methyl ether.....	$CHCl_3$	1.054		-201.5	(608)
	β -Isonitrosoepicamphor- <i>o</i> -methyl ether.....	$CHCl_3$	1.046		-173.6	
$C_{11}H_{18}O_3$	<i>l</i> -Epiborneolcarboxylic acids (A, M. P. 125°)	AcOEt	4.64	19	2.36	(237)
	(B, M. P. 145°)	AcOEt	5.52	19	-4.8	
	(C, M. P. 173°)	AcOEt	1.09	19	15.2	
	(D, M. P. 237°)	AcOEt	0.69	19	77.9	
$C_{16}H_{21}N_3O$	α - (β -)Isonitrosoepicamphor phenylhydrazone	EtOH	1.139		142	(608)
		$CHCl_3$	1.139		259.2	
$C_{17}H_{19}NO_3$	Benzoyl- α -isonitrosoepicamphor.....	$CHCl_3$	1.045		128.7	(608)
	Benzoyl- β -isonitrosoepicamphor.....	$CHCl_3$	1.036		130.0	
$C_{17}H_{20}N_2O_3$	β -Isonitrosoepicamphor phenylurethane.....	$CHCl_3$	1.026		-124.3	(608)
	α -Isonitrosoepicamphor phenylurethane.....	$CHCl_3$	0.236		-110.2	

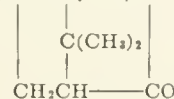
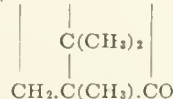
CAMPHOR AND DERIVATIVES

Camphor and hydroxy, alkyl and alkylidene derivatives

$C_{10}H_{16}O$	Camphor 	PhMe	4.494	20	43.45	(306)
		90% EtOH	10		43.0	(630)
		90% EtOH	10		39.66	
		60% EtOH	2.5		32.32	
		C_6H_6	4		40.62	
		olive oil	10		53.15	

* $CH_3.CH-C(CH_3)_2$ 

† Mutarotation.

§ $CH_2.C(CH_3).CH_2$ || $CH_2.CH-CH_2$ 

Camphor and hydroxy, alkyl and alkylidene derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₅ H ₁₆ O	Camphor.—(Continued).....	C ₂ H ₄ Cl ₂	50.58	11.7	51.94	(1599)
		C ₂ H ₄ Cl ₂	52.68	15.7	52.68	
C ₁₀ H ₁₆ O ₂	<i>l</i> -Camphor.....	EtOH	20.13	20	−41.45	
	β-Hydroxycamphor.....	EtOH	9.57		12.3	(1368)
	α-Hydroxycamphor.....	EtOH	9.45		12.8	
C ₁₁ H ₁₆ NO ₃	Nitromethylenecamphor.....	CHCl ₃	0.980		88	(613)
		12% Na-EtOH	0.980		0*	
		10% NaOH	0.988		36.6*	(613)
C ₁₁ H ₁₆ O	Methylenecamphor.....	EtOH			127.5	(1431.5)
C ₁₁ H ₁₇ NO ₂	α, α-Nitromethylenhydroxycamphor.....	CHCl ₃	1.0400		−159.5	(613)
C ₁₁ H ₁₈ O	α-Methoxycamphor.....		0.9314 ₂₀	20	−27.31	(582)
		C ₆ H ₆	2.00	20	−24.5	
C ₁₁ H ₁₈ O	α-Methylcamphor.....	EtOH	5	25	30	(723); <i>cf.</i> (1429)
C ₁₂ H ₁₈ O	Ethylidenecamphor.....	EtOH			113	(1433)
C ₁₂ H ₂₀ O	Ethylcamphor.....	EtOH	27.9	15	45.48	(1281); <i>cf.</i> (813, 1433)
C ₁₂ H ₂₀ O	Dimethylcamphor.....		0.9471 ₄ ²⁵	24	92.7	(805)
C ₁₃ H ₂₀ O	Allylcamphor.....	EtOH	10.0	14	79.62	(1281)
C ₁₃ H ₂₂ O	Propylcamphor.....	EtOH	9.89	15	60.95	(1281); <i>cf.</i> (813, 823)
C ₁₃ H ₂₂ O	Methylethylcamphor.....	EtOH	2.01	16	98.65	(1281)
		EtOH		18	99.4	(813)
C ₁₄ H ₂₄ O	Diethylcamphor.....	EtOH		15	91.21	(813)
		EtOH	7.44	15	91.35	(1281)
C ₁₄ H ₂₄ O	Isobutylcamphor.....	EtOH			72.4	(823)
C ₁₅ H ₂₄ O	Diallylcamphor.....	EtOH	16.1	17	152.37	(1281)
C ₁₆ H ₂₈ O	Dipropylcamphor.....	EtOH	8.28	17	54.35	(1281); <i>cf.</i> (813)
C ₁₇ H ₁₉ BrO	<i>o</i> -Bromobenzylidenecamphor.....	PhMe			283	(820)
	<i>p</i> -Bromobenzylidenecamphor.....	PhMe			315	
C ₁₇ H ₁₉ ClO	Phenylchloromethylenecamphor.....	C ₆ H ₆	1.00	20	−217	(584)
C ₁₇ H ₁₉ NO ₃	<i>o</i> -Nitrobenzylidenecamphor.....	CHCl ₃			50	(2212)
	<i>m</i> -Nitrobenzylidenecamphor.....	CHCl ₃	4.67		311	
	<i>p</i> -Nitrobenzylidenecamphor.....	CHCl ₃	1.5510		437	
C ₁₇ H ₂₀ O ₂	Salicylidenecamphor.....	EtOH	0.845	23	469	(804)
		0.1 <i>N</i> KOH	3.27		820	
C ₁₇ H ₂₀ O ₂	<i>m</i> -Hydroxybenzylidenecamphor.....	EtOH	0.859	23	423	(804)
		0.1 <i>N</i> KOH	0.436	19	507	
		EtOH	0.852	23	500	
C ₁₇ H ₂₂ O	<i>p</i> -Hydroxybenzylidenecamphor.....	0.1 <i>N</i> KOH	0.450	22	770	
		EtOH	6.23	14	149.10	(1281); <i>cf.</i> (813)
C ₁₈ H ₁₉ NO	Phenylcyanomethylenecamphor.....	CHCl ₃	1.0432		246	(613)
C ₁₈ H ₂₁ NO ₂	Phenylcarboxamidemethylenecamphor.....	CHCl ₃	1.044		281.1	(613)
C ₁₈ H ₂₂ C ₂	Piperonylidenecamphor.....	PhMe	8.11	20	133.74	(824)
C ₁₈ H ₂₂ O ₂	<i>o</i> -Methoxybenzylidenecamphor.....	PhMe			431.5	(792)
	<i>p</i> -Methoxybenzylidenecamphor.....	PhMe			467.07	
C ₁₈ H ₂₄ O	<i>m</i> -Tolylidenecamphor.....	EtOH	0.858	24	396	(804)
		EtOH	0.815	23	458	
C ₁₈ H ₂₄ O ₂	<i>m</i> -Methoxybenzylcamphor.....	PhMe	6.207	20	127.36	(824)
	<i>p</i> -Methoxybenzylcamphor.....	PhMe	7.77	20	95.43	
C ₁₉ H ₂₂ O	Cinnamylidenecamphor.....	C ₆ H ₆	10.07	20	269.74	(1827)
		CHCl ₃	10.10	20	296.11	
C ₁₉ H ₂₄ O	β, β-Phenylmethylethylidenecamphor.....	EtOH	4.84	15	126.1	(1557)
C ₁₉ H ₂₆ O	β, β-Phenylmethylethylcamphor.....	EtOH	7.34	15	39.23	(1557)
C ₁₉ H ₂₆ O	γ-Phenylpropylcamphor.....	CHCl ₃	10.2	20	66.53	(1827)
C ₁₉ H ₂₆ O	Ethylbenzylcamphor.....	EtOH	8.27	19	90.62	(1281); <i>cf.</i> (813)
		EtOH	6.81	19	91.50	
C ₁₉ H ₂₆ O ₂	Ethylsaligenylcamphor.....	PhMe	6.59	20	102.69	(824)
C ₂₀ H ₂₆ C	β, β-Phenylethylethylidenecamphor.....	EtOH	2.53	15	122.28	(1557)
C ₂₀ H ₂₈ O	β, β-Ethylphenylethylcamphor.....	EtOH	9.28	15	31.37	(1557)

* Mutarotation.

Camphor and hydroxy, alkyl and alkylidene derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₂₀ H ₂₈ O	Cuminylecamphor.....	PhMe	6.506	20	89.25	(824)
C ₂₀ H ₃₀ O	Bornylenecamphor.....	EtOH			69.2	(763)
C ₂₁ H ₂₈ O	β, β- <i>n</i> -Propylphenylethylidenecamphor.....	EtOH	2.77	15	127.20	(1557)
		EtOH	3.05	15	126.75	
	β, β-Isopropylphenylethylidenecamphor.....	EtOH	5.04	15	115.35	
C ₂₁ H ₃₀ O	β, β- <i>n</i> -Propylphenylethylcamphor.....	EtOH	8.47	15	35.80	(1557)
	β, β-Isopropylphenylethylcamphor.....	EtOH	8.65	15	27.65	
C ₂₃ H ₂₄ O	Diphenylmethylenecamphor.....	EtOH			287	(803)
C ₂₃ H ₂₆ O ₂	β-Ethoxy-α-naphthylidenecamphor.....	EtOH	5.32		121.13	(847)
C ₂₄ H ₂₈ O	Dibenzylcamphor.....	EtOH	1.63	20	102.12	(1281); cf. (813)
C ₃₈ H ₄₆ O ₂	<i>trans</i> -Diphenylpropylenedicamphor.....	CHCl ₃	10.2	20	40.63	(1827)
	<i>cis</i> -Diphenylpropylenedicamphor.....	CHCl ₃	10.1	20	30.22	
<i>Imines, oximes and hydrazones of camphor, etc.</i>						
C ₁₀ H ₁₆ BrNO	β-Bromocamphoroxime (C ₁₀ H ₁₅ Br:NOH)...	CHCl ₃	2.0	21	-73.5	(582)
C ₁₁ H ₁₉ NO	α-Methylcamphoroxime.....	EtOH	5	20	30.3	(723)
	Methylcamphoroxime.....	EtOH	4.88	22	25.15	
C ₁₁ H ₁₉ N ₃ O ₂	<i>l</i> -Campherol semicarbazone.....	EtOH	8.45	17	-5.91	(1406); cf. (1358)
C ₁₂ H ₁₉ NO	Acetylcamphorimine*.....	CHCl ₃	1.07		263.2	(602)
C ₁₂ H ₂₁ NO	Ethylcamphoroxime.....	EtOH	3.03	13	46.17	(1281); cf. (813)
C ₁₃ H ₂₁ NO	Allylcamphoroxime.....	EtOH	2.52	14	55.88	(1281)
C ₁₃ H ₂₃ NO	Propylcamphoroxime.....	EtOH	8.09	15	53.98	(1281)
C ₁₇ H ₂₀ BrNO ₂	β-Benzoyl-β-bromocamphoroxime.....	CHCl ₃	2.02		-39.2	(582)
C ₁₇ H ₂₂ N ₂ O	Camphor benzoylhydrazone†.....	CHCl ₃	1.516		-50.5	(612)
C ₁₈ H ₂₄ N ₂ O ₂	Methylcamphoroxime phenylurethane.....	EtOH	3.67	22	25.3	(806)
C ₂₄ H ₂₈ N ₄ O ₃	Camphoroximephenylcarbamate phenylcarbamide.....	EtOH	1.04	15	-56.6	(1173)
<i>Halogen derivatives of camphor, methylcamphor and benzylcamphor</i>						
C ₁₀ H ₁₃ Br ₂ ClO	α, β-Dibromo-α-chlorocamphor.....	C ₂ H ₄ Cl ₂	36.67	13.0	43.02	(1599)
C ₁₀ H ₁₃ Br ₃ O	α, α', β-Tribromocamphor.....	Me ₂ CO	2.42	9	2	(41)
C ₁₀ H ₁₃ ClO	Trichlorocamphor.....	EtOH	4.57		51.2	(272)
C ₁₀ H ₁₄ BrClO	α, α'-Chlorobromocamphor.....	CHCl ₃			62.4	(272.5)
	α, β-Chlorobromocamphor.....	CHCl ₃			40.8	
C ₁₀ H ₁₄ Br ₂ O	α, α'-Dibromocamphor.....	C ₂ H ₄ Cl ₂	34.29	15.5	42.07	(1599)
	α, β-Dibromocamphor.....	C ₂ H ₄ Cl ₂	25.81	14.9	104.17	(261)
		Me ₂ CO	5		127‡	
		EtOH	2.35		120‡	
		C ₆ H ₆	16.23		101‡	
C ₁₀ H ₁₄ Br ₂ O	α', β-Dibromocamphor.....	Me ₂ CO	5		85‡	
		EtOH	0.6		73‡	
		C ₆ H ₆	16.14		83‡	
	α, π-Dibromocamphor.....	AcOH	1		135.0‡	
		AcOEt	5		128.9‡	
		EtOH	0.66		128.1‡	
		Me ₂ CO	5		128.2‡	
		Me ₂ CO	7.5		128.3‡	
		CHCl ₃	10		125.9‡	
		CHCl ₃	2		126.4‡	
		C ₂ H ₄ Br ₂	5		140.9‡	
		PhMe	5		108.4‡	
		C ₆ H ₆	14.75		110.8‡	
C ₁₀ H ₁₄ Br ₂ O	α', π-Dibromocamphor.....	AcOH	1		99.0‡	
		AcOEt	5		108.6‡	
		EtOH	0.66		109.0‡	
		Me ₂ CO	5		111.7‡	
		CHCl ₃	10		118.6‡	
		CHCl ₃	2		119.5‡	
		C ₂ H ₄ Br ₂	5		120.0‡	

* C₈H₁₄ $\begin{array}{c} \text{CH}_2 \\ | \\ \text{C:N.CO.CH}_3 \end{array}$. † C₁₀H₁₆: N.NH.COC₆H₅. ‡ $[\alpha]_{589}$.

Halogen derivatives of camphor, methylcamphor and benzylcamphor.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₀ H ₁₄ Br ₂ O	α', π-Dibromocamphor.—(Continued)	PhMe	5		120.9*	(261)
		C ₆ H ₆	5.63		126.6*	
C ₁₀ H ₁₄ Cl ₂ O	α, α'-Dichlorocamphor.	EtOH			45.8	(270.5)
		EtOH			48.5	
		CHCl ₃			45.9	
	α, β-Dichlorocamphor.	EtOH			48.5	
		CHCl ₃			45.9	
C ₁₀ H ₁₄ I ₂ O	Diiodocamphor	CHCl ₃	2.8		28	(1393)
C ₁₀ H ₁₅ BrO	α-Bromocamphor	C ₂ H ₄ Cl ₂	43.75	12.4	145.3	(1599)
		EtOH	9.96	20	134.8	(2100)
		EtOH	0.514	20	137.1	
		Et ₂ O	9.76	20	136.3	
		Et ₂ O	0.923	20	138.8	
		Me ₂ CO	7.72	20	141.5	
		Me ₂ CO	0.529	20	140.0	
		AcOEt	8.69	20	139.7	
		AcOEt	0.555	20	139.6	
		C ₆ H ₆	10.17	20	120.5	
		C ₆ H ₆	0.472	20	120.7	
		EtOH	5		164.75*	(1330)
	α'-Bromocamphor	EtOH	5		−38.1	
	Equilibrium mixture, α⇌α'	KOH.EtOH	5		147.8	
	<i>l</i> -Bromocamphor.	C ₆ H ₆	1.67		117.1	(1667)
	<i>d</i> -Bromocamphor.	C ₆ H ₆	1.66		−118.2	
	β-Bromocamphor; <i>cf.</i> (280, 780, 1390, 1449, 2172.5)	CHCl ₃	2.01	20	16.3	(582)
		EtOH	2.01	20	19.1	
		Me ₂ CO	3.33	14	19.2	(41)
C ₁₀ H ₁₅ ClO	α-Chlorocamphor.	C ₂ H ₄ Cl ₂	32.02	12.4	106.5	(1599)
		EtOH	5		95.8	(1285); <i>cf.</i> (271, 279)
C ₁₁ H ₁₇ BrO	Methylbromocamphor.	EtOH			176.8	(1431.5)
	Bromomethylcamphor.	EtOH			150.5	
C ₁₁ H ₁₇ BrO	α-Bromo-α-methylcamphor.	EtOH	5	20	184.4	(723)
	ω-Bromo-α-methylcamphor.	EtOH	5	20	155.4	
	β-Bromo-α-methylcamphor.	EtOH	1.72	25	18.8	
C ₁₇ H ₂₁ BrO	Benzylbromocamphor (form a)	EtOH			61	(820)
	(form b)	EtOH			20	
Nitro derivatives of camphor						
C ₁₀ H ₁₃ Br ₂ NO ₃	α, β-Dibromo-α'-nitrocamphor.	Me ₂ CO	4.74	10	−25.7	(41)
C ₁₀ H ₁₄ BrNO ₃	Bromonitrocamphor.	EtOH	1		−21.7	(271.5); <i>cf.</i> (1306)
C ₁₀ H ₁₄ ClNO ₃	α, α'-Chloronitrocamphor.	C ₂ H ₄ Cl ₂	43.80	12.8	6.92	(1599)
C ₁₀ H ₁₃ BrNO ₃ K.2H ₂ O	Potassium pseudonitrobromocamphor.	H ₂ O	4.68	12	91	(1286.5)
C ₁₀ H ₁₅ NO ₃	α-Nitrocamphor.	C ₂ H ₄ Cl ₂	49.87	12.0	19.47†	(1599)
C ₂₀ H ₂₈ N ₂ O ₅	Anhydro-ψ-nitrocamphor.	C ₂ H ₄ Cl ₂	15.96	14.9	132.84	(1599)
Cyano derivatives of camphor and of alkyl camphors						
C ₁₁ H ₁₆ NO	Cyanocamphor.	PhMe			44.68	(779, 790)
		C ₆ H ₆	4.12		0	(822)
		PhMe	4.12		4.03	
		<i>p</i> -Xylene	4.12		3.03	
		EtOH	4.12		12.16	
		MeCN	2.70		27.92	
		EtCN	2.66		28.58	
		MeI	4.12		37.3	
		PrI	4.12		36.6	
		CH ₂ O ₂	4.12		42.4	
		AcOH	4.12		45.4	
		<i>iso</i> -PrCO ₂ H	4.12		48.4	
C ₁₂ H ₁₇ NO	α-Methylecyanocamphor.				150.8	(818); <i>cf.</i> (786)
	β-Methylecyanocamphor.				90.1	

* [α]_D461. † Mutarotation.

Cyano derivatives of camphor and of alkyl camphors.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₄ H ₁₉ NO	Cyano- <i>C</i> -allylcamphor.....	PhMe			49	(793)
	Cyano- <i>O</i> -allylcamphor.....	PhMe			124	
C ₁₄ H ₂₁ NO	Cyano- <i>O</i> -propylcamphor.....	EtOH			126	(793)
	Cyano- <i>C</i> -propylcamphor.....	EtOH			90	
<i>Sulfur derivatives of camphor: Sulfides, sulfoxides, etc.</i>						
C ₁₀ H ₁₆ OS	Camphor-β-thiol.....	Me ₂ CO	10	11	6	(1301)
C ₁₀ H ₁₆ O ₃ S	Camphor-β-sulfinic acid.....	H ₂ O	2.0	20	-74.50	(907, 1968)
	Sodium salt.....	H ₂ O	0.885	19	-58.2	(1968)
	Zinc salt.....	H ₂ O	4.00	19	-33.8	(1968)
C ₁₀ H ₁₆ O ₃ S ₂	Camphor β-thiosulfonate.....	H ₂ O	5.0	16.5	11.52	(907)
C ₁₀ H ₁₅ S	Thiocamphor.....	AcOEt	3.64	15	-41.70	(2222)
C ₁₁ H ₁₈ O ₃ S ₂	Camphorylmethyl β-disulfoxide (C ₁₀ H ₁₅ O.SO.SO.CH ₃).....	CHCl ₃	2.5	16.5	44.48*	(907)
		HCl.EtOH	1.0	22	29.50*	
C ₁₂ H ₁₈ O ₂ S	Camphor-β-thiol acetate.....	EtOH	5	8	-41	(1301)
C ₁₄ H ₂₄ O ₃ S ₂	Camphoryl- <i>n</i> -butyl β-disulfoxide.....	CHCl ₃	1.0	17	-23.60	(907)
C ₁₆ H ₂₀ O ₂ S	Camphor-β-thiol benzoate.....	Me ₂ CO	3.22	13	-16.4	(1301)
C ₂₀ H ₂₀ O ₄ S ₂	Dicamphoryl α, β-disulfoxide ([SO.C ₁₀ H ₁₅ O] ₂)	CHCl ₃	5.0	16.5	-64.68*	(907)
		CHCl ₃	1.0	16.5	-68.80	
		EtOH	1.0	16.5	-65.20	
		HCl.EtOH	1.0	17.5	-52.40*	
		AcOH	1.0	20	-58.60	
C ₂₀ H ₃₀ O ₆ S ₂	<i>d</i> -Camphoryl-α-disulfone ([SO ₂ .C ₁₀ H ₁₅ O] ₂)...	CHCl ₃	2.03	22	30.6	(1968)
C ₂₀ H ₃₀ O ₆ S ₃	Camphor-β-sulfonic thioanhydride (S(SO ₂ .C ₁₀ H ₁₅ O) ₂).....	CHCl ₃	2.5	19	-31.68	(909)
C ₂₀ H ₃₀ O ₆ S ₄	Dicamphor-β-sulfonyl disulfide (S[SO ₂ .C ₁₀ H ₁₅ O] ₂).....	CHCl ₃	2.5	19	-108.56	(909)
C ₄₈ H ₅₈ Cl ₆ O ₆ PtS ₂	Camphoryldianisylsulfonium chloroplatinate† (in epichlorohydrin).....		2.009	22	-51.8	(1968)
C ₅₂ H ₆₆ Cl ₆ O ₆ PtS ₂	Camphoryldiphenethylsulfonium chloroplatinate (in epichlorohydrin).....		2.02	28	-57.3	
<i>Sulfur derivatives of camphor: β-Sulfonic derivatives of camphor, methylcamphor, α-chlorocamphor, α-bromocamphor and α, α'-dibromocamphor</i>						
C ₁₀ H ₁₃ Br ₂ NO ₂ S	α, α'-Dibromocamphor-β-sulfonanhydramide	Me ₂ CO	5	11	-7.2	(40)
C ₁₀ H ₁₄ BrClO ₃ S	α-Bromocamphor-β-sulfonyl chloride.....	CHCl ₃	10	5	104	(40)
C ₁₀ H ₁₄ BrNO ₂ S	α-Bromocamphor-β-sulfonanhydramide.....	EtOH	2.51		134	(1302.5)
		Me ₂ CO	5	20	99.3	(40)
	α'-Bromocamphorsulfonanhydramide.....	Me ₂ CO	5	14	40.5	
C ₁₀ H ₂₄ Br ₂ O ₃ S	α-Bromocamphor-β-sulfonic bromide.....	CHCl ₃	4	12	119	(40)
C ₁₀ H ₁₄ ClNO ₂ S	α-Chlorocamphor-β-sulfonanhydramide.....	EtOH	1.28		39.0	(1302.5)
		Me ₂ CO	5	11	59.5	(40)
C ₁₀ H ₁₄ Cl ₂ O ₃ S	α-Chlorocamphor-β-sulfonic chloride.....	CHCl ₃	5	11	80.8	(40)
C ₁₀ H ₁₅ BrO ₃ S	Camphor-β-sulfonic bromide.....	CHCl ₃	10	18	26.0	(40)
C ₁₀ H ₁₅ BrO ₄ S	α-Bromo-β-camphorsulfonic acid, potassium salt.....	H ₂ O	26.56		72.1	(1302.5)
	Sodium salt.....	H ₂ O	3.422	14	12.22	(1390)
C ₁₀ H ₁₅ ClO ₃ S	Camphor-β-sulfonic chloride.....	CHCl ₃	10	18	31.1	(40); cf. (1080)
		CHCl ₃	5	20	32.01	(910)
C ₁₀ H ₁₅ ClO ₄ S	α-Chlorocamphor-β-sulfonic acid.....	H ₂ O	17.92		49.6	(1302.5)
	Barium salt (5.5H ₂ O).....	H ₂ O	2.081	10	46.8	(1080)
	Sodium salt.....	H ₂ O	2.01	10	64	(1080)
C ₁₀ H ₁₅ NO ₂ S	Camphor-β-sulfonanhydramide.....	EtOH	0.46		-45.0	(1302.5)
C ₁₀ H ₁₆ BrNO ₃ S	α-Bromocamphor-β-sulfonamide.....	EtOH	2.0		89.0	(1302.5)
		Me ₂ CO	5	17	106	(40)
C ₁₀ H ₁₆ ClNO ₃ S	α-Chlorocamphor-β-sulfonamide.....	EtOH	3.05		75.0	(1302.5)
		Me ₂ CO	5	15	83.2	(40)
C ₁₀ H ₁₆ O ₄ S	Camphor-β-sulfonic acid.....	CHCl ₃	5.0	20	39.47	(910)
		H ₂ O	5.0	20	23.95	
	Ammonium salt.....	H ₂ O			20.1	(268)
C ₁₀ H ₁₇ NO ₃ S	Camphor-β-sulfonamide.....	EtOH	4.3		23.0	(1302.5)
		CHCl ₃	10	17	1.5	(40)

* Mutarotation.

† [(CH₃.O.C₆H₄)₂S.C₁₀H₁₅O].P₄Cl₆.

Sulfur derivatives of camphor: β -Sulfonic derivatives of camphor, methylcamphor, α -chlorocamphor, α -bromocamphor and α , α' -dibromocamphor.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₁ H ₁₇ ClO ₃ S	α -Methylcamphor- β -sulfonyl chloride.....	C ₆ H ₆	5	20	29.5	(723)
C ₁₁ H ₁₈ O ₄ S	Methylcamphor β -sulfonate (C ₁₁ H ₁₈ O ₄ .SO ₂ .C ₁₀ H ₁₆ O).....	CHCl ₃	5.0	23	43.61	(408)
		CHCl ₃	2.5	23	43.4	
C ₁₁ H ₁₈ O ₄ S	α -Methylcamphor- β -sulfonic acid.....	H ₂ O	5.04	20	18.7	(723)
C ₁₁ H ₁₉ NO ₃ S	α -Methylcamphor- β -sulfonamide.....	CHCl ₃	2.5	20	-6.3	(723)
C ₁₂ H ₂₀ O ₄ S	Ethyl camphor- β -sulfonate.....	CHCl ₃	5.0	23	43.91	(408)
		CHCl ₃	2.5	23	43.28	
C ₁₆ H ₂₄ BrNO ₃ S	α -Bromocamphorsulfonpiperidide.....	CHCl ₃	3	13	111	(40)
C ₁₆ H ₂₅ NO ₃ S	Camphor- β -sulfonpiperidide M. P. 140° isomer (a).....	CHCl ₃	5	15	32.2	(40)
	M. P. 56° isomer (b).....	CHCl ₃	10	10	33.6	
C ₁₆ H ₁₉ BrClNO ₃ S	α -Chlorocamphor- β -sulfon- <i>p</i> -bromoanilide...	H ₂ O	6.55		73.6	(1302.5)
C ₁₆ H ₁₉ Br ₂ NO ₃ S	α -Bromocamphor- β -sulfon- <i>p</i> -bromoanilide...	EtOH	15.53		209.0	(1302.5)
C ₁₆ H ₂₀ BrNO ₃ S	α -Bromocamphorsulfonanilide.....	CHCl ₃	4.2	7	177	(40)
C ₁₆ H ₂₀ BrNO ₃ S	Camphor- β -sulphon- <i>p</i> -bromoanilide.....	EtOH	1.35		21.4	(1302.5)
C ₁₆ H ₂₀ O ₄ S	Phenol camphor- β -sulfonate.....	CHCl ₃	2.5	22	40.56	(909); cf. (408)
C ₁₆ H ₂₁ NO ₃ S	Camphor- β -sulfonanilide.....	EtOH	7.44		27.4	(1302.5)
C ₁₆ H ₂₁ NO ₃ S	Camphorsulphonanilide.....	CHCl ₃	10	17	67.3	(40)
C ₁₇ H ₂₀ O ₅ S	<i>o</i> -Aldehydophenyl camphor- β -sulfonate....	CHCl ₃	2.5	23	39.6	(408)
C ₁₇ H ₂₂ O ₄ S	<i>o</i> -Tolyl camphor- β -sulfonate.....	CHCl ₃	2.5	21	46.0	(904); cf. (408)
		CHCl ₃	5.0	21	45.8	
C ₁₇ H ₂₃ NO ₃ S	Camphor- β -sulfonyl- <i>p</i> -toluidide.....	CHCl ₃	2.5	21	71.2	(904)
		CHCl ₃	5.0	21	68.3	(604)
C ₁₈ H ₂₃ NO ₄ S	Camphor- β -sulfonyl- <i>p</i> -acetylanilide.....	CHCl ₃	2.5	23	67.0	(904)
		CHCl ₃	5.0	23	67.2	
C ₁₈ H ₂₅ NO ₃ S	Camphor- β -sulfonyl- <i>p</i> -ethylphenylamide...	CHCl ₃	2.5	21	63.8	(904)
		CHCl ₃	5.0	21	63.6	
C ₂₀ H ₂₂ O ₄ S	α -Naphthyl camphor- β -sulfonate.....	CHCl ₃	2.5	23	38.24	(408)
	β -Naphthyl camphor- β -sulfonate.....	CHCl ₃	2.5	23	30.16	
C ₂₀ H ₂₆ O ₅ S	Eugenyl camphor- β -sulfonate.....	CHCl ₃	2.5	21	28.4	(904)
		CHCl ₃	5.0	21	27.8	
	Isoeugenyl camphor- β -sulfonate.....	CHCl ₃	2.5	21	26.4	
		CHCl ₃	5.0	21	27.6	
C ₂₂ H ₂₄ O ₅ S	2-Aceto- α -naphthyl camphor- β -sulfonate....	CHCl ₃	2.5	23	50.02	(408)
C ₂₃ H ₂₅ NO ₄ S	Camphor- β -sulfonyl- <i>p</i> -benzoylanilide.....	CHCl ₃	2.5	21	55.6	(904)
		CHCl ₃	5.0	21	57.1	
C ₂₆ H ₂₆ O ₅ S	α , β -Benzoylvinylphenyl camphor- β -sulfonate, C ₆ H ₅ .CO.CH : CH.C ₆ H ₄ .O.SO ₂ .C ₁₀ H ₁₆ O....	CHCl ₃	2.5	23	27.2	(408)
C ₂₆ H ₃₄ O ₈ S ₂	Pyrocatechol dicamphor- β -sulfonate.....	CHCl ₃	2.5	22	42.72	(909)
C ₂₆ H ₃₄ O ₈ S ₂	Resorcinol dicamphor- β -sulfonate.....	CHCl ₃	2.5	22	42.48	(909)
C ₂₆ H ₃₄ O ₈ S ₂	Hydroquinone dicamphor- β -sulfonate.....	CHCl ₃	2.5	22	50.00	(909)
C ₂₆ H ₄₈ O ₄ S	Cetyl camphor- β -sulfonate.....	CHCl ₃	2.5	20	21.74	(910)
C ₃₆ H ₄₈ O ₁₂ S ₃	Pyrogallol tricamphor- β -sulfonate.....	CHCl ₃	2.5	22	27.60	(909)
C ₃₆ H ₄₈ O ₁₂ S ₃	Phloroglucinol tricamphor- β -sulfonate.....	CHCl ₃	2.5	22	57.64	(909)
C ₄₀ H ₇₆ O ₄ S	Myricyl camphor- β -sulfonate.....	CHCl ₃	2.5	20	15.30	(910)
<i>Sulfur derivatives of camphor: π-Sulfonic derivatives of camphor, α-chlorocamphor and α-bromocamphor</i>						
C ₁₀ H ₁₄ BrClO ₃ S	α -Bromocamphor- π -sulfonyl chloride.....	CHCl ₃	5.486	14	131	(1080)
C ₁₀ H ₁₄ BrO ₄ SNH ₄	Ammonium <i>d</i> -bromocamphor- π -sulfonate....	H ₂ O	1.81		84.4	(1667)
	Ammonium <i>l</i> -bromocamphor- π -sulfonate....	H ₂ O	1.81		-84.2	
C ₁₀ H ₁₄ BrO ₄ SNH ₄	Ammonium α -bromo- π -camphorsulfonate....	H ₂ O	18.57		75.1	(1302.5)
C ₁₀ H ₁₄ Cl ₂ O ₃ S	α -Chlorocamphor- π -sulfonyl chloride.....	CHCl ₃	4	7	110.5	(1080)
C ₁₀ H ₁₆ O ₄ SNH ₄	Ammonium <i>d</i> -camphor- π -sulphonate.....	EtOH	0.5001		80.5	(1676)
		H ₂ O	2.499		68.0	
		H ₂ O	1.515		66.3	
		H ₂ O	0.53		68.9	
	Ammonium <i>l</i> -camphor- π -sulfonate.....	EtOH	0.537		-80.1	(1676)
		H ₂ O	2.50		-68.3	
		H ₂ O	1.51		-67.9	
		H ₂ O	0.51		-68.6	

Sulfur derivatives of camphor: π -Sulfonic derivatives of camphor, α -chlorocamphor and α -bromocamphor.—(Continued)

Formula	Name	Solvent	d , C or %	t , °C	$[\alpha]_D$	Lit.
$C_{10}H_{16}BrNO_3S$	α -Bromocamphor- π -sulfonamide.....	EtOH	4.595	11	112.4	(1080)
		EtOH	11.61		67.2	(1302.5)
$C_{10}H_{16}ClNO_3S$	α -Chlorocamphor- π -sulfonamide.....	EtOH	5.066	11	90.16	(1080)
$C_{31}H_{37}N_2O_6S$	Strychnine α -camphor- π -sulfonate.....	EtOH	0.5237		23.9	(1676)
		$CHCl_3$	0.5318		22.6	
		H_2O	0.5321		11.3	
	Strychnine l -camphor- π -sulfonate.....	EtOH	0.5166		-48.4	
		$CHCl_3$	0.5442		-63.4	
		H_2O	0.5017		-50.8	
α -Diketones and Derivatives						
<i>Camphorquinone oximes, including isonitrosocamphor</i>						
$C_{10}H_{14}N_2O_2$	Camphorquinone dioxime peroxide.....	EtOH	2.00	20	18.7	(585)
$C_{10}H_{16}NO_2$	Isonitrosocamphor (camphorquinone monoxime) $\left(C_8H_{14} \begin{array}{c} \diagup C: NOH \\ \\ \diagdown CO \end{array} \right)$	C_6H_6	0.81		195	(278)
	(stable M. P. 152°).....	$CHCl_3$	1.0		197.0	(589)
	(stable M. P. 152°).....	2% NaOH	1.0		288.0	
	(unstable M. P. 114°).....	$CHCl_3$	1.0		172.9	
	(unstable M. P. 114°).....	2% NaOH	1.0		275.3	
$C_{10}H_{15}N_2O_2$	Pernitrosocamphorquinoneoxime.....	$CHCl_3$	0.566		103.1	(612)
$C_{10}H_{16}N_2O_2$	Camphorquinone- α -dioxime.....	$CHCl_3$	1.0		-51.7	(589); cf.
		2% NaOH	1.0		-103.8	(608)
	Camphorquinone- β -dioxime.....	2% NaOH	1.0		-24.5	
	Camphorquinone- γ -dioxime.....	$CHCl_3$	1.0		16.4	
		2% NaOH	1.0		14.3	
	Camphorquinone- δ -dioxime.....	$CHCl_3$	1.0		52.8	
		2% NaOH	1.0		87.0	
	Camphorquinone- α -dioxime.....	EtOH	1.57	20	-63.6	(585)
		2% NaOH	2.58	20	-98.3	
	Camphorquinone- β -dioxime.....	2% NaOH	1.87	20	-24.1	
	Camphorquinone- γ -dioxime.....	EtOH	1.00	20	22.4	
		2% NaOH	18.1		12.6	
	Camphorquinone- δ -dioxime.....	2% NaOH	1.85		83.6	
$C_{10}H_{16}N_4O$	Camphorylazoinideoxime.....	EtOH	1.02	21	75.5	
		C_6H_6	2.01		-198.2	(594)
		EtOH	2.01		-160.1	
		Me_2CO	2.05		-163.7	
		$CHCl_3$	2.09		-161.3	
$C_{11}H_{17}NO_2$	Isonitrosocamphor O -methyl ether.....	$CHCl_3$	2.01		197.7	(586)
	Isonitrosocamphor N -methyl ether.....	$CHCl_3$	4.55		279.8	(586)
$C_{12}H_{19}NO_2$	Isonitrosocamphor N -ethyl ether.....	$CHCl_3$	1.246		248.1	(599)
$C_{17}H_{19}N_3O_4$	Benzoylpernitrosocamphorquinoneoxime....	$CHCl_3$	0.596		84.7	(612)
<i>Camphorquinone hydrazones</i>						
$C_{10}H_{16}N_2O$	Camphorquinone α -hydrazone.....	$CHCl_3$	1.244		287.4	(614)
	Camphorquinone β -hydrazone.....	$CHCl_3$	1.253		231.3	
$C_{11}H_{16}N_2O_2$	Formylcamphorquinone α -hydrazone.....	$CHCl_3$	0.688		258.0	(614)
$C_{12}H_{18}N_2O_2$	Acetylcamphorquinone α -hydrazone.....	$CHCl_3$	1.113		265.5	(614)
		10% NaOH	0.833		252.0	
	Acetylcamphorquinone β -hydrazone.....	$CHCl_3$	1.556		223.8	
$C_{16}H_{19}BrN_4O_2$	Pernitrosocamphorquinone p -bromophenyl- hydrazone.....	$CHCl_3$	1.176		301.0	(612)
	Isomeride.....	$CHCl_3$	0.934		235.5*	
$C_{16}H_{20}N_2O$	Camphorquinone phenylhydrazone.....	EtOH	1		438	(1172)
		$AcOEt$	1		380*	
$C_{16}H_{20}N_2O$	Camphorquinone α -phenylhydrazone.....	EtOH	1.0		398*	(615)
		Py	1.0		435.5	
		$PhNO_2$	1.0		453.9	
$C_{16}H_{20}N_2O$	Camphorquinone β -phenylhydrazone.....	EtOH	1.0		397*	(615)
		Py	1.0		395.5	
		C_6H_6	1.0		369.5	
		$PhNO_2$	1.0		420.5	

* Mutarotation

Camphorquinone hydrazones.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₆ H ₂₀ N ₄ O ₂	Pernitrosocamphorquinone phenylhydrazone.	CHCl ₃	0.498		374.4	(612)
C ₁₆ H ₂₁ N ₃ O	Camphorquinone phenylhydrazonoxime....	CHCl ₃	0.883		147	(611)
C ₁₇ H ₂₀ N ₂ O	Benzylidenecamphorquinone α-hydrazone...	CHCl ₃	1.517		159.2	(614)
C ₁₇ H ₂₀ N ₂ O ₂	α-Benzoylcamphorquinone α-hydrazone....	CHCl ₃	0.427		204.9	(614)
C ₂₀ H ₂₈ N ₂	Dicamphenepyrizine.....	CHCl ₃	1.020		55.5	(608)
C ₂₀ H ₂₈ N ₂ O ₂	Azocamphanone.....	CHCl ₃	0.260	30	188	(1955)
	$\left(\text{C}_8\text{H}_{14} \begin{array}{c} \diagup \text{C:N:N:C} \diagdown \\ \quad \quad \\ \text{CO} \quad \text{CO} \end{array} \text{C}_8\text{H}_{14} \right)$	MeOH	0.166	30	229	
		CHCl ₃	1.242		174.5	(614)
C ₂₀ H ₃₀ N ₂	Dihydrodicamphenepyrizine.....	CHCl ₃	1.047		−283.3	(608)
C ₂₀ H ₃₀ N ₂	Epidihydrodicamphenepyrizine.....	CHCl ₃	1.042		425.5	(608)
C ₂₂ H ₂₄ N ₂ O	Camphorquinone diphenylhydrazone.....	C ₆ H ₆	0.513		126.6	(44)
C ₂₃ H ₂₆ N ₂ O	Camphorquinone benzylphenylhydrazone...	C ₆ H ₆	0.49		636	(44)
<i>Cyclic derivatives of camphorquinone</i>						
C ₁₁ H ₁₅ N ₃ O	Camphanehydroxytriazine*.....	CHCl ₃	1.142		22.6	(614)
C ₁₁ H ₁₅ N ₃ S	Camphanethiotriazine†.....	CHCl ₃	1.0		−73.3	(615)
C ₁₃ H ₁₇ N ₃ O ₂	Acetylcamphanehydroxytriazine.....	CHCl ₃	1.222		42.2	(614)
C ₁₆ H ₁₈ N ₂	Camphanoquinoxaline.....	EtOH	2.497	23.0	31.4‡	(1952)
		CHCl ₃	1.999	27.0	29.26‡	
		MeOH	2.138	30.0	33.45	
C ₁₆ H ₂₀ BrN ₃ O	Camphoryl- <i>p</i> -bromophenyltriazene.....	CHCl ₃	0.915		62.7	(595)
C ₁₆ H ₂₀ N ₂	Camphoranodihydroquinoxaline.....	CHCl ₃	1.144	20	−180.0‡	(1952)
C ₁₆ H ₂₀ N ₄ O ₃	Camphoryl- <i>o</i> -nitrophenyltriazene.....	CHCl ₃	0.425		−242.8	(595)
	Camphoryl- <i>m</i> -nitrophenyltriazene.....	CHCl ₃	0.5		0	
	Camphoryl- <i>p</i> -nitrophenyltriazene.....	CHCl ₃	0.435		114.8	
C ₁₆ H ₂₁ N ₃ O	Camphorylphenyltriazene§.....	CHCl ₃	1.57		18.6	(595)
C ₁₇ H ₂₂ BrN ₃ O	Camphoryl- <i>p</i> -bromophenylmethyltriazene (needles).....	CHCl ₃	0.90		−218.0	(595)
	Camphoryl- <i>p</i> -bromophenylmethyltriazene (prisms).....	CHCl ₃	0.90		−232.1	
C ₁₇ H ₂₂ N ₄ O ₃	Camphoryl- <i>o</i> -nitrophenylmethyltriazene....	CHCl ₃	0.94		301.0	(595)
	Camphoryl- <i>m</i> -nitrophenylmethyltriazene....	CHCl ₃	0.495		181.6	
	Camphoryl- <i>p</i> -nitrophenylmethyltriazene...	CHCl ₃	1.18		310.8	
C ₁₇ H ₂₃ N ₃ O	Camphorylphenylmethyltriazene.....	CHCl ₃	1.08		235.2	(595)
C ₁₇ H ₂₃ N ₃ O ₂	Camphoryl- <i>p</i> -methoxyphenyltriazene.....	CHCl ₃	0.84		49.0	(595)
C ₁₈ H ₁₉ N ₃ O ₂	Benzoylcamphanehydroxytriazine.....	CHCl ₃	1.123		7.7	(614)
<i>Camphorquinone semicarbazones</i>						
C ₁₁ H ₁₇ N ₃ O ₂	Camphorquinone α-semicarbazone.....	MeOH	1.576		277.6	(614)
		very dil. KOH	1.337		333.3	
	Camphorquinone β-semicarbazone.....	MeOH	1.576		200.9	
C ₁₁ H ₁₇ N ₃ OS	Camphorquinone α-thiosemicarbazone.....	CHCl ₃	1.0		314.4	(615)
C ₁₇ H ₂₁ N ₂ OS	Camphorquinone phenylthiocarbamylhydra- zone.....	CHCl ₃	1.0		259.4	(615)
C ₁₇ H ₂₁ N ₃ O ₂	Camphorquinone α-phenylcarbamyl- hydrazine.....	CHCl ₃	0.883		229.3	(614)
	Camphorquinone β-phenylcarbamyl- hydrazine.....	CHCl ₃	0.851		191.9	
<i>β-Diketones and enolic isomerides</i>						
C ₁₇ H ₁₈ BrNO ₄	α'- <i>m</i> -Nitrobenzoyl-α-bromocamphor.....	CHCl ₃	1.56	21	87.9	(606)
	α- <i>m</i> -Nitrobenzoyl-α'-bromocamphor.....	CHCl ₃	1.85	21	−26.1	
C ₁₇ H ₁₈ ClNO ₄	α'- <i>m</i> -Nitrobenzoyl-α-chlorocamphor.....	CHCl ₃	2.24	20	40.4	(606)
	α- <i>m</i> -Nitrobenzoyl-α'-chlorocamphor.....	CHCl ₃	1.75	21	7.1	
C ₁₇ H ₁₈ N ₂ O ₆	α'- <i>m</i> -Nitrobenzoyl-α-nitrocamphor.....	CHCl ₃	2.00	20	175.6	(601)
	α- <i>m</i> -Nitrobenzoyl-α'-nitrocamphor.....	CHCl ₃	2.00	20	178.1	
C ₁₇ H ₁₉ BrO ₂	α'-Benzoyl-α-bromocamphor.....	C ₆ H ₆	2.0	21	−10.0	(605)
		CHCl ₃	2.01	21	10.3	
	α-Benzoyl-α'-bromocamphor.....	C ₆ H ₆	2.00	21	−53.2	
		CHCl ₃	2.58	21	−19.3	
C ₁₇ H ₁₉ ClO ₂	α'-Benzoyl-α-chlorocamphor.....	CHCl ₃	1.67	21	−27.9	(605)
	α-Benzoyl-α'-chlorocamphor.....	CHCl ₃	1.59	21	26.2	
C ₁₇ H ₁₉ IO ₂	Benzoyliodocamphor.....	CHCl ₃	2.05	21	47.7	(601)

* C₈H₁₄ $\begin{array}{c} \diagup \text{C:N:N} \diagdown \\ | \quad \quad || \\ \text{C:N.CO} \end{array}$ † C₈H₁₄ $\begin{array}{c} \diagup \text{C:N:N} \diagdown \\ | \quad \quad || \\ \text{C:N.C.SH} \end{array}$ ‡ Mutarotation. § C₁₀H₁₅O.N:N.NH.C₆H₅.

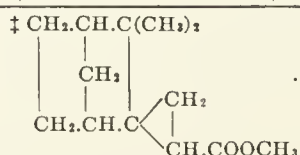
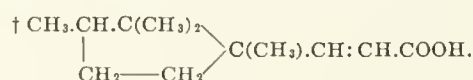
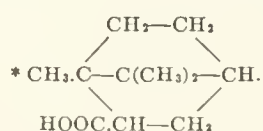
Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _{<i>D</i>}	Lit.
C ₁₇ H ₁₉ NO ₄	<i>m</i> -Nitrobenzoylcamphor (enolic).....	CHCl ₃	1.96	20	209.5	(606)
	<i>o</i> -Nitrobenzoylcamphor (enolic).....	CHCl ₃	1.86	21	60.5*	
C ₁₇ H ₁₉ NO ₄	α', α'-Benzoylnitrocamphor.....	CHCl ₃	2.00	25	163.0	(601)
	α, α'-Benzoylnitrocamphor.....	CHCl ₃	2.00	20	245.2	
C ₁₇ H ₂₀ O ₂	α-Benzoylcamphor $\left(\text{C}_8\text{H}_{14} \begin{array}{c} \swarrow \text{CH.CO.C}_6\text{H}_5 \\ \downarrow \\ \searrow \text{CO} \end{array} \right)$	EtOH CHCl ₃	1.00 2.00	21 21	137.5 125.0	(580)
C ₁₇ H ₂₀ O ₂	α-Hydroxy-β-benzoylcamphene (enolic isomeride) $\left(\text{C}_8\text{H}_{14} \begin{array}{c} \swarrow \text{C.CO.C}_6\text{H}_5 \\ \parallel \\ \searrow \text{COH} \end{array} \right)$	CHCl ₃ EtOH	2.05 1.17	21 21	216* 208*	(580)
C ₂₄ H ₂₄ O ₃	α-Benzoxo-β-benzoylcamphene $\left(\text{C}_8\text{H}_{14} \begin{array}{c} \swarrow \text{C.CO.C}_6\text{H}_5 \\ \parallel \\ \searrow \text{C.O.CO.C}_6\text{H}_5 \end{array} \right)$	CHCl ₃ EtOH	4.01 1.01	22 27	189.7 187.3	(580)
C ₂₄ H ₂₆ O ₂	Enolic benzoylcamphor benzyl ether.....	CHCl ₃	2.32	21	155.8	(584)

Fencholic and campholic acids and derivatives						
C ₁₀ H ₁₇ ClO	Fenchyl chloride ((CH ₃) ₂ C.C ₆ H ₁₀ .COCl).....		1.0045 ²⁰	19	-2.43	(2122)
C ₁₀ H ₁₈ O ₂	Campholic acid (CH ₃ .C ₈ H ₁₄ .COOH).....	C ₆ H ₆		20	59.26	(1818) (1832)
C ₁₀ H ₁₉ NO ₂	α-Aminocampholic acid.....	H ₂ O	2.07	26	67	(1528)
	β-Aminocampholic acid.....	H ₂ O	2.5	25	16.4	
C ₁₀ H ₂₀ ClNO ₂	α-Aminocampholic hydrochloride.....	H ₂ O	5.0	24	44.7	(1528)
	β-Aminocampholic hydrochloride.....	H ₂ O	5.0	26	41.3	
C ₁₁ H ₁₈ N ₂ O	Cyanocampholic amide (CN.CH ₂ .C ₈ H ₁₄ .CO.NH ₂).....	EtOH	1.05	16	85.63	(1553)
C ₁₂ H ₂₂ O ₂	Dimethylcampholic acid ((CH ₃) ₂ .CH.C ₈ H ₁₄ .COOH).....	EtOH			47.4	(805)
C ₁₂ H ₂₂ O ₂	Ethyl campholate (CH ₃ .C ₈ H ₁₄ .COOC ₂ H ₅)...			20	40.49	(1818) (1832)
C ₁₂ H ₂₃ NO	Dimethylcampholamide.....	EtOH			70.8	(805)
C ₁₃ H ₂₄ O ₂	Methylethylcampholic acid.....	EtOH	2.41	15	55.40	(1281)
C ₁₄ H ₂₆ O ₂	Diethylcampholic acid.....	EtOH	3.45	15	60.87	(1281)
C ₁₄ H ₂₇ NO	Diethylcampholamide.....	EtOH	2.68	18	77.08	(1281)
C ₁₆ H ₂₇ NO	Diallylcampholamide.....	EtOH	8.48	18	40.50	(1281)
C ₁₇ H ₂₃ BrO ₂	Phenylbromohomocampholic acid (C ₆ H ₅ .CHBr.CH ₂ .C ₈ H ₁₄ .COOH).....	PhMe			44.8	(820)
C ₁₇ H ₂₃ BrO ₃	p-Bromophenylhydroxyhomocampholic acid (BrC ₆ H ₄ .CHOH.CH ₂ .C ₈ H ₁₄ .COOH).....	PhMe			57.05	(820)
C ₁₈ H ₂₃ NO ₂	o-Tolyl cyanocampholate (CN.CH ₂ .C ₈ H ₁₄ .COOC ₆ H ₄ .CH ₃).....	EtOH	8.95	12	21.6	(1553)
	m-Tolyl cyanocampholate.....	C ₆ H ₆	10.5	21	26.1	
		EtOH	9.9		26.2	
	p-Tolyl cyanocampholate.....	C ₆ H ₆	5.7	20	17.5	
C ₂₄ H ₃₁ NO	Dibenzylcampholamide ((C ₆ H ₅ .CH ₂) ₂ CH.C ₈ H ₁₄ .CO.NH ₂).....	EtOH	2.72	19	33.12	(1281)
		EtOH	2.52	19	34.30	
Other monocarboxylic acids						
C ₉ H ₁₇ O ₂	Dihydrolauronic acid†.....		0.9008	25.5	1.74	(1516)
C ₉ H ₁₆ O ₂	Teresantalic acid‡.....	EtOH	25	18	-70.40	(1925)
C ₁₀ H ₁₈ O ₂	Dihydrofencholenic acid§.....		0.9816 ¹⁵	15.5	4.3	(1359)
C ₁₀ H ₁₆ NO ₂	Cyanodihydrocampholytic acid 	EtOH	6.0	22	25.3	(1528)
C ₁₀ H ₁₆ NO ₂	Cyanocamphoranic acid¶.....	EtOH	10	26	67.3	
C ₁₁ H ₁₆ O ₂	Bornylene-2-carboxylic acid**.....	AcOEt	3.30		-95.7	(238)
C ₁₁ H ₁₇ N	Camphanecarboxylic acid nitrile.....	MeOH	12.3		1	(613)

* Mutarotation. $\begin{array}{c} \dagger \text{CH}_2-\text{CH}_2 \\ | \\ \text{CH}_3.\text{C}(\text{CH}_3)_2 \end{array} \rangle \text{CH}(\text{CH}_3).\text{COOH}.$ $\dagger \begin{array}{c} \text{CH}_2-\text{CH}_2 \\ | \\ \text{CH}_3.\text{CH}.\text{CH}(\text{CH}_3) \end{array} \rangle \text{C}.\text{CH}_3.\text{COOH}.$ $\S \text{C}_7\text{H}_{11} \begin{array}{c} \text{CH}_2 \\ | \\ \text{CH}.\text{COOH} \end{array}.$ $\parallel \text{CN}.\text{CH}.\text{C}(\text{CH}_3)_2 \begin{array}{c} \text{CH}_2-\text{CH}_2 \end{array} \rangle \text{C}(\text{CH}_3).\text{COOH}.$
 $\P \text{CN}.\text{C}(\text{CH}_3).\text{C}(\text{CH}_3)_2 \begin{array}{c} \text{CH}_2-\text{CH}_2 \end{array} \rangle \text{CH}.\text{COOH}.$ $** \text{C}_6\text{H}_{11} \begin{array}{c} \text{CH} \\ || \\ \text{C}.\text{COOH} \end{array}.$

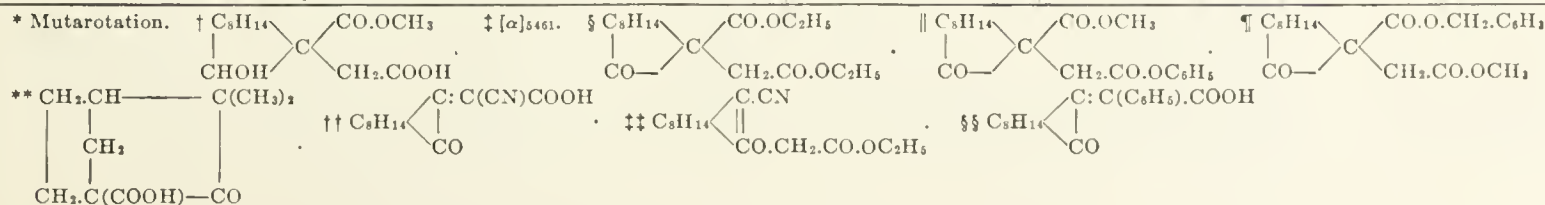
Other monocarboxylic acids.—(Continued)

Formula	Name	Solvent	d, C or %	t, °C	[α] _D	Lit.
C ₁₁ H ₁₈ O ₂	l-Camphane-2-carboxylic acid*.....	AcOEt	3.74	19	−37.8	(237); cf. (238)
C ₁₂ H ₁₈ O ₂	Methyl bornylene-2-carboxylate.....	AcOEt	7.17		−93.6	(238)
		AcOEt	2.88	19	−98.8	(237)
C ₁₂ H ₂₀ O ₂	1, 2, 2, 3-Tetramethylcyclopentane-1-acrylic acid†.....	C ₆ H ₆		20	66.82	(1835)
C ₁₃ H ₂₀ O ₂	Methyl 2, 2-dimethyl-norcamphane-3-spirocyclopropanecarboxylate‡.....		1.0268	18.5	6.79	(257)
C ₁₄ H ₂₄ O ₂	Ethyl 1, 2, 2, 3-tetramethylcyclopentane-1-acrylate.....			20	57.51	(1835)
		C ₆ H ₆		2	57.11	
KETONIC ACIDS						
Derivatives of cyclopentanone and cyclopentanol						
C ₉ H ₁₄ O ₃	Methyl 1-4-dimethyl-2-cyclopentanonecarboxylate $\left(\begin{array}{c} \text{CH}_2\text{CO} \\ \\ \text{CH}_3\text{CH}-\text{CH} \end{array} \right) \text{C}(\text{CH}_3)\text{CO.OCH}_3 \dots$		1.053	15	78.58	(811)
C ₉ H ₁₆ O ₃	d-cis-2-Hydroxy-1, 2, 3-trimethylcyclopentane-1-carboxylic acid $\left(\begin{array}{c} \text{CH}_3\text{CH.C.CH}_3\text{OH} \\ \\ \text{CH}_2-\text{CH}_2 \end{array} \right) \text{C}(\text{CH}_3)\text{COOH} \dots$	EtOH	5.69	23	35.7	(1956)
C ₁₀ H ₁₆ O ₃	Methyl 4-methyl-1-ethyl-2-cyclopentanonecarboxylate $\left(\begin{array}{c} \text{CH}_2\text{CO} \\ \\ \text{CH}_3\text{CH.CH}_2 \end{array} \right) \text{C}(\text{C}_2\text{H}_5)\text{CO.OCH}_3 \dots$		1.041	15	59.14	(811)
C ₁₀ H ₁₈ O ₃	Ethyl 1, 4-dimethyl-2-cyclopentanonecarboxylate $\left(\begin{array}{c} \text{CH}_2\text{CO} \\ \\ \text{CH}_3\text{CH}-\text{CH}_3 \end{array} \right) \text{C}(\text{CH}_3)\text{CO.OC}_2\text{H}_5 \dots$		1.01	15	70.00	(811)
C ₁₁ H ₁₈ O ₃	Methyl 4-methyl-1-allyl-2-cyclopentanonecarboxylate $\left(\begin{array}{c} \text{CH}_2\text{CO} \\ \\ \text{CH}_3\text{CH.CH}_2 \end{array} \right) \text{C}(\text{C}_3\text{H}_5)\text{CO.OCH}_3 \dots$		1.029	15	58.18	(811)
C ₁₁ H ₁₈ O ₃	Methyl 4-methyl-1-propyl-2-cyclopentanonecarboxylate $\left(\begin{array}{c} \text{CH}_2\text{CO} \\ \\ \text{CH}_3\text{CH.CH}_2 \end{array} \right) \text{C}(\text{C}_3\text{H}_7)\text{CO.OCH}_3 \dots$		1.02	15	53.3	(811)
C ₁₁ H ₁₈ O ₃	Ethyl 4-methyl-1-ethyl-2-cyclopentanonecarboxylate.....		1.01	15	51.7	(811)
C ₁₁ H ₁₈ O ₃	Propyl 1, 4-dimethyl-2-cyclopentanonecarboxylate.....		0.991	15	50.28	(811)
C ₁₂ H ₁₈ O ₃	Ethyl 4-methyl-1-allyl-2-cyclopentanonecarboxylate.....		1.01	15	62.16	(811)
C ₁₂ H ₂₀ O ₃	Ethyl 4-methyl-1-propyl-2-cyclopentanonecarboxylate.....		1.00	15	51.8	(811)
C ₁₃ H ₂₂ O ₃	Ethyl 4-methyl-1-isobutyl-2-cyclopentanonecarboxylate.....		0.994	15	30.33	(811)
Camphorcarboxylic acid and isomers, homologues and derivatives						
C ₁₀ H ₁₆ O ₃	α-Thujaketonic acid.....	Et ₂ O	6.945		194.0	(2022); cf. (2114)
		AcOH	4.6163		224.1	
		CHCl ₃	5.132		244.8	
		H ₂ O	0.6754		244.0	
		MeOH	5.5649		214.8	
	Ammonium salt.....	H ₂ O	0.881	19	170	(2022)



Camphorcarboxylic acid and isomers, homologues and derivatives.—(Continued)

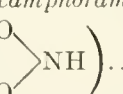
Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₀ H ₁₇ NO ₃	α-Thujaketonic acid oxime (alk. prep.)..... (neutral prep.).....	MeOH AcOH MeOH	3.933 1.7008 4.473		−5.0 5.56 very small	(2022)
C ₁₁ H ₁₆ O ₃	<i>l</i> -Epicamphorcarboxylic acid.....	AcOEt	3.89	19	−18.5	(237)
C ₁₁ H ₁₆ O ₃	<i>d</i> -Camphor-α-carboxylic acid..... $\left(\text{C}_8\text{H}_{14} \begin{array}{c} \diagup \text{CH.COOH} \\ \\ \diagdown \text{CO} \end{array} \right)$	C ₆ H ₆ EtOH MeCN EtI H ₂ O NaOH H ₂ O EtOH	1.52 1.52 1.52 1.52 1.52 1.52 1.52 1		18 60 62.5 73.3 73.3 87.5 61.9	(822) (440)
C ₁₁ H ₁₇ NO ₂	<i>l</i> -Camphorcarboxylic acid..... Camphorcarboxamide (λ = 5461).....	EtOH EtOH	1 1	18 18	−61.9 100	(440) (724)
C ₁₁ H ₁₉ N ₃ O ₃	α-Thujaketonic semicarbazone.....	AcOH	2.29	16	227.8	(2022)
C ₁₂ H ₁₈ O ₃	Camphoracetic acid (C ₁₀ H ₁₆ O.CH ₂ .COOH).. EtOH	EtOH	2.30	14	72.6 70.7	(1553) (797)
C ₁₂ H ₁₈ O ₃	Methyl camphorcarboxylate.....				161.22*	(724); cf. (1288)
C ₁₂ H ₁₉ NO ₃	Camphoroximeacetic acid $\left(\text{C}_8\text{H}_{14} \begin{array}{c} \diagup \text{CH.CH}_2\text{.COOH} \\ \\ \diagdown \text{C:NOH} \end{array} \right)$	EtOH	3.38	21	−5.9	(598)
C ₁₃ H ₁₈ BrNO ₃	Acetyl α, α'-bromocamphorcarboxamide....	C ₆ H ₆	2		−0.5*	(724)
C ₁₃ H ₂₀ O ₂	Camphor-β-propionic acid (C ₁₀ H ₁₆ O.CH ₂ .CH ₂ .COOH).....	EtOH			45.6	(797)
C ₁₃ H ₂₀ O ₃	α-Methyl methylcamphorcarboxylate.....	EtOH			17.25	(1432)
C ₁₃ H ₂₀ O ₃	β-Methyl methylcamphorcarboxylate.....	EtOH			75	
C ₁₄ H ₂₂ O ₃	α-Methyl ethylcamphorcarboxylate.....	EtOH			58	(1432)
C ₁₄ H ₂₂ O ₃	β-Methyl ethylcamphorcarboxylate.....	EtOH			87.8	
C ₁₄ H ₂₂ O ₃	1-Methyl acid campholethanoyl-1- methanoate†.....	EtOH	2.7	20	49.37	(1553)
C ₁₆ H ₂₂ O ₃	Dimethyl carboxycamphoracetate.....	EtOH			65.70	(797)
C ₁₆ H ₂₄ O ₃	Methyl <i>l</i> -α-propylcamphor-α-carboxylate (isomeride a)..... (isomeride b).....	EtOH EtOH			52.57 49.73	(793)
C ₁₆ H ₂₅ NO ₂	Camphorcarboxypiperidide (C ₁₀ H ₁₆ O.CO.N.C ₅ H ₁₀).....	C ₆ H ₆ EtOH			24.9† 111†	(724)
C ₁₇ H ₂₆ O ₃	Diethyl-1-ethanoatecamphomethanoate§....	EtOH	11.89	12.5	59.7	(1553)
C ₁₈ H ₂₂ O ₃	Benzyl camphorcarboxylate (C ₁₀ H ₁₆ O.CO.O.CH ₂ .C ₆ H ₅).....	EtOH	1.66	15	58.23	(1553)
C ₂₀ H ₂₄ O ₃	Phenylmethyl ethanoatecampho- methanoate 	EtOH	3.2	16	41.6	(1553)
C ₂₁ H ₂₆ O ₃	1-Methyl 1-benzylethanoate- camphomethanoate¶.....	EtOH	9.03	22	46.0	(1553)
Other ketonic acids, including their nitriles and derivatives of enol forms						
C ₁₀ H ₁₄ O ₃	<i>d</i> -Camphenonic acid**.....	EtOH	8.0	20	79.1	(62)
C ₁₀ H ₁₆ NO ₂	<i>l</i> -Camphenonic amide.....	EtOH	2.8	20	−58.3	(62)
C ₁₁ H ₁₆ BrNO	Cyanodihydrocarvone hydrobromide.....	EtOH	1.415	14	25.5	(328)
C ₁₁ H ₁₆ ClNO	Cyanodihydrocarvonehydrochloride.....	EtOH	1.289	14	25.8	
C ₁₁ H ₁₇ NO ₂	β-Dihydrocarvonecarboxamide.....	EtOH	3.208	18	25.6	(328)
C ₁₃ H ₁₆ NO ₃	Camphorylideneacyanoacetic acid††.....	EtOH	0.9340	18.5	71.2	(328)
C ₁₆ H ₁₉ NO ₃	Ethyl camphorylideneacyanoacetate.....	CHCl ₃	1.052		223.4	(613)
C ₁₆ H ₂₁ NO ₃	Ethyl cyanocamphoracetate††.....	CHCl ₃	1.012		201.2	(613)
C ₁₈ H ₂₀ O ₃	Ethyl cyanocamphoracetate††.....	CHCl ₃	1.09		79.44	(810)
C ₁₈ H ₂₀ O ₃	Camphorylidenephenylacetic acid§§.....	CHCl ₃	1.0072		233.3	(613)



DICARBOXYLIC ACIDS
Thujadicarboxylic acid and derivatives

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₉ H ₁₂ O ₃	α-Thujadicarboxylic anhydride.....	Et ₂ O	4.069	17	10.1	(2022)
		CHCl ₃	2.642	13	8.43	
C ₉ H ₁₄ O ₄	α-Thujadicarboxylic acid.....	Et ₂ O	4.991		105.1	(2022)
	$\left(\text{CH}_2 \begin{array}{c} \swarrow \text{CH.CO.OH} \\ \\ \searrow \text{C}(\text{C}_3\text{H}_7)\text{CH}_2.\text{CO.OH} \end{array} \right)$	AcOH	4.9177		133.2	
		CHCl ₃	2.8726		171.5	
		MeOH	4.7043		104.0	
		H ₂ O	0.7323		135.1	
		H ₂ O	3.805	18	-5.3	
		H ₂ O	1.90		-7.1	
	Ammonium salt.....	H ₂ O	0.793	17	15.2	(2022)
C ₉ H ₁₅ NO ₃	α-Thujadicarboxylic monoamide.....	MeOH	3.777	15	54.5	(2022)
	Ammonium α-thujadicarboxamate.....	H ₂ O	1.713	17	-17.6	(2022)
		MeOH	4.694	18	9.2	
C ₁₁ H ₁₈ O ₄	Dimethyl α-thujadicarboxylate.....		1.054	18	142.5	(2022)
		Et ₂ O	4.748	20	142.1	
		Et ₂ O	10.86	20	139.2	
			1.0535	20	142.5	(2123)
C ₁₃ H ₂₂ O ₄	Diethyl α-thujadicarboxylate.....		1.019	19	114.1	(2022)
		Et ₂ O	5.135	18	115.9	
		Et ₂ O	10.073	18	106.0	
C ₁₅ H ₂₆ O ₄	Di- <i>n</i> -propyl α-thujadicarboxylate.....		0.9973	12	84.7	(2022)
		Et ₂ O	6.786	17	85.2	
C ₁₆ H ₂₀ O ₄	Benzyl hydrogen α-thujadicarboxylate.....	Et ₂ O	4.566	17	34.7	(2022)
C ₁₇ H ₃₀ O ₄	Diisobutyl α-thujadicarboxylate.....		0.991	12	77.62	(2022)
		Et ₂ O	5.577	12	71.6	
		Et ₂ O	13.709	12	73.0	
C ₁₉ H ₃₄ O ₄	Diisoamyl α-thujadicarboxylate.....		0.9924	15	73.5	(2022)
		Et ₂ O	4.4314	16	73.1	
<i>Fenchocamphoric acid and derivatives</i>						
C ₁₀ H ₁₄ O ₃	<i>cis-d</i> -Isfenchocamphoric anhydride.....	C ₆ H ₆	10.48	18.5	13.33	(1858)
C ₁₀ H ₁₅ NO ₂	<i>d-cis</i> -Isfenchocamphoric imide.....	EtOH	10.35	18	-12.73	(1858)
C ₁₀ H ₁₆ O ₄	Isfenchocamphoric acid.....	Et ₂ O	2.603	11	-12.75	(2130)
	<i>l-cis</i> -Isfenchocamphoric acid.....	EtOH	9.3	21	-14.54	(1858)
	<i>d-trans</i> -Isfenchocamphoric acid.....	EtOH	10	21	4.21	
C ₁₀ H ₁₇ NO ₃	α-Amino- <i>trans-d</i> -isfenchocamphoric acid...	EtOH	1.57	18	7.98	(1858)
	β-Amino- <i>trans-d</i> -isfenchocamphoric acid...	EtOH	1.68	17	9.71	
	β-Amino- <i>cis-d</i> -isfenchocamphoric acid.....	EtOH	8.6	17	8.91	(1858)
	α-Amino- <i>cis-l</i> -isfenchocamphoric acid.....	EtOH	1.7	20	-11.18	
C ₁₀ H ₁₈ N ₂ O ₂	<i>d-trans</i> -Isfenchocamphodiamide.....	EtOH	6	17	-6.18	(1858)
C ₁₂ H ₂₀ O ₄	Dimethyl <i>trans-l</i> -isfenchocamphorate.....		1.0471 ²⁰	16	1.18	(1858)
	Dimethyl <i>cis-d</i> -isfenchocamphorate.....		1.0470 ²⁰	21	19.17	
C ₁₄ H ₂₄ O ₄	Diethyl <i>d-trans</i> -isfenchocamphorate.....		1.0057	20	-1.05	(1858)
	Diethyl <i>l-cis</i> -isfenchocamphorate.....		1.0073	20	-11.16	
C ₂₂ H ₂₆ N ₂ O ₂	<i>l-trans</i> -Isfenchocamphoric dianilide.....	EtOH	7.69	15	20.69	(1858)
	<i>d-cis</i> -Isfenchocamphoric dianilide.....	EtOH	2.39	18.5	26.26	(1858)
<i>Camphoric acid and camphorates</i>						
C ₁₀ H ₁₃ BrO ₃	β-Bromocamphoric anhydride.....	Me ₂ CO	5	9	-2.8	(41)
C ₁₀ H ₁₄ O ₃	Camphoric anhydride; cf. (57, 833, 1388)....	C ₆ H ₆	0.7705		-7.12	(1449)
C ₁₀ H ₁₅ BrO ₄	β-Bromocamphoric acid.....	EtOH	5	11	39.3	(41)
		CHCl ₃	2.5	21	46.4	(904)
C ₁₀ H ₁₆ O ₄	Camphoric acid $\left(\text{C}_8\text{H}_{14} \begin{array}{c} \swarrow \text{COOH} \\ \\ \searrow \text{COOH} \end{array} \right)$; for	CHCl ₃	5.0	21	46.0	(833)
	camphorates, cf. (1162, 2021).....	Me ₂ CO	15	20	50.81	
	Ammonium salt.....	AcOH	15	20	46.66	
	Barium salt.....	H ₂ O	10	20	17.87	(833)
	Calcium salt.....	H ₂ O	10	20	12.21	(833)
	Lithium salt.....	H ₂ O	10	20	17.69	(833)
	Magnesium salt.....	H ₂ O	10	20	20.08	(833)
	Potassium salt.....	H ₂ O	10	20	19.70	(833)
	Sodium salt.....	H ₂ O	10	20	14.48	(833)
C ₁₀ H ₁₆ O ₄	Isocamphoric acid; cf. (57, 686, 1388).....	EtOH	10		16.91	(833)
C ₁₁ H ₁₇ BrO ₄	Monomethyl β-bromocamphorate.....	Me ₂ CO	4.79	10	-47.6	(1524)
					53.6	

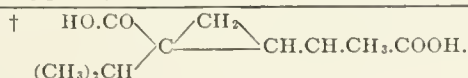
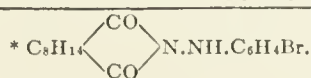
Camphoric acid and camphorates.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₁ H ₁₈ O ₄	Allomethyl hydrogen camphorate.....				43.55	(788)
	Orthomethyl hydrogen camphorate.....				51.52	
	Methyl hydrogen camphorate.....	CHCl ₃	5.0	23	57.71	(408)
		CHCl ₃	2.5	23	58.50	
	α-Methyl β-hydrogen isocamphorate.....	EtOH	10		−57.9	(1522)
	α-Methyl hydrogen isocamphorate.....	EtOH	10		−58.4	(1524)
C ₁₂ H ₂₀ O ₄	β-Methyl hydrogen isocamphorate.....	EtOH	10		−53.1	
	Dimethyl camphorate.....		1.0747 ₄ ²⁰	22	48.16	(251); <i>cf.</i> (788; 2101)
C ₁₂ H ₂₀ O ₄	Dimethyl isocamphorate.....		1.073 ₄ ²⁰	21	−65.2	(1522)
C ₁₂ H ₂₀ O ₄	Ethyl hydrogen camphorate.....	EtOH	10		−63.6	(1524)
		CHCl ₃	5	23	38.72	(408)
C ₁₂ H ₂₀ O ₄	Alloethyl hydrogen camphorate.....	CHCl ₃	2.5	23	39.8	
			1.1004		23.9	(687)
C ₁₂ H ₂₀ O ₄	Orthoethyl hydrogen camphorate.....		1.1133		39.18	
C ₁₂ H ₂₀ O ₄	Orthoethyl hydrogen isocamphorate.....		1.1156		−49.51	(687)
C ₁₃ H ₂₂ O ₄	Allomethyl orthoethylcamphorate.....		1.0528 ₄ ²²	22.2	38.43	(251)
			1.0448 ₄ ²²	22.2	45.49	
C ₁₃ H ₂₂ O ₄	<i>n</i> -Propyl hydrogen camphorate.....	CHCl ₃	5.0	23	38.76	(408)
		CHCl ₃	2.5	23	38.56	
C ₁₄ H ₂₄ O ₄	Diethyl camphorate.....		1.0301	19.6	36.30	(251); <i>cf.</i> (687)
C ₁₄ H ₂₄ O ₄	Diethyl isocamphorate.....		1.0473		−48.53	(687)
C ₁₄ H ₂₄ O ₄	<i>n</i> -Butyl hydrogen camphorate.....	CHCl ₃	5.0	23	35.6	(408)
		CHCl ₃	2.5	23	36.24	
C ₁₆ H ₂₀ O	Phenyl hydrogen camphorate.....	CHCl ₃	2.5	23	45.38	(408)
C ₁₇ H ₂₀ O ₅	Orthoaldehydophenyl hydrogen camphorate.	CHCl ₃	2.5	23	48.1	(408)
C ₁₇ H ₂₂ O ₄	Orthotolyl hydrogen camphorate.....	CHCl ₃	2.5	21	45.0	(904); <i>cf.</i>
		CHCl ₃	5.0	21	45.2	(408)
C ₁₈ H ₃₈ N ₂ O ₄	Dibutylamine camphorate.....	CHCl ₃	2.5	20	39.9	(408)
C ₂₀ H ₂₂ O ₄	α-Naphthyl hydrogen camphorate.....	CHCl ₃	2.5	23	34.24	(408)
		CHCl ₃	2.5	23	53.28	(408)
C ₂₀ H ₂₄ O ₅	Orthoacetylvinylphenyl hydrogen camphorate	CHCl ₃	2.5	23	30.04	(408)
C ₂₀ H ₂₆ O ₅	Eugenyl hydrogen camphorate.....	CHCl ₃	2.5	21	32.0	
		CHCl ₃	5.0	21	32.7	(904)
C ₂₀ H ₂₆ O ₅	Isoeugenyl hydrogen camphorate.....	CHCl ₃	2.5	21	38.0	(904)
		CHCl ₃	5.0	21	38.6	
C ₂₀ H ₃₄ O ₄	<i>o</i> -Menthyl hydrogen camphorate.....	C ₆ H ₆	1.567	20	−16.6	(344)
C ₂₂ H ₂₄ O ₅	2-Aceto-α-naphthyl hydrogen camphorate...	CHCl ₃	2.5	23	38.00	(408)
C ₂₄ H ₃₂ N ₂ O ₄	Di- <i>p</i> -toluidine camphorate.....	CHCl ₃	2.5	21	24.0	(904); <i>cf.</i>
		CHCl ₃	5.0	21	22.9	(408)
C ₂₆ H ₂₆ O ₅	Ortho-β-benzoylvinyphenyl hydrogen camphorate.....	CHCl ₃	2.5	23	49.44	(408)
C ₂₆ H ₃₂ N ₂ O ₅	Di- <i>p</i> -aminoacetophenone camphorate.....	CHCl ₃	2.5	21	19.4	(904)
		CHCl ₃	5.0	21	19.2	
C ₂₆ H ₄₈ O ₄	Cetyl hydrogen camphorate.....	CHCl ₃	5.0	20	20.43	(908)
C ₂₇ H ₂₆ O ₅	2-Benzoyl-α-naphthyl hydrogen camphorate	CHCl ₃	2.5	23	52.82	(1553)
C ₃₆ H ₃₆ N ₂ O ₅	Di- <i>p</i> -aminobenzophenone camphorate.....	CHCl ₃	2.5	21	12.4	(904); <i>cf.</i>
		CHCl ₃	5.0	21	12.2	(408)
C ₄₀ H ₇₆ O ₄	Myricyl hydrogen camphorate.....	CHCl ₃	2.5	20	14.85	(908)
		CHCl ₃	5.0	20	14.29	
<i>Camphorimide, camphoramide and camphoramic acid and derivatives</i>						
C ₁₀ H ₁₅ NO ₂	Camphorimide (C ₈ H ₁₄ ).....	Me ₂ CO			−10.1	(2212,
		CHCl ₃	20		5.45	1997)
		CHCl ₃	5		1.55	
C ₁₀ H ₁₇ NO ₃	α-Camphoramic acid					
	(HO.CO.C ₈ H ₁₄ .CO.NH ₂).....	Me ₂ CO			45	(2212)
C ₁₀ H ₁₈ N ₂ O ₂	Camphoramide (C ₈ H ₁₄ (CO.NH ₂) ₂).....	CHCl ₃			−10.6	(758.5)
C ₁₁ H ₁₇ NO ₂	Methylcamphorimide.....	Me ₂ CO	2.3	20	7.26	(2212)
C ₁₁ H ₁₉ NO ₃	<i>N</i> -Methyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	33.24	(2212)
C ₁₁ H ₁₉ NO ₃	α-Methyl β-camphoramate.....	EtOH		27	57.25	(807)
		EtOH		25	23.33	

Camphorimide, camphoramide and camphoramic acid and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₁ H ₁₉ NO ₃	β-Methyl isocamphoramate.....	EtOH	10		−54.4	(1524)
	α-Methyl β-isocamphoramate.....	EtOH	10		−60.05	(1522)
C ₁₂ H ₁₉ NO ₂	<i>N</i> -Ethylcamphorimide.....	Me ₂ CO	2.3	20	8.87	(2212)
C ₁₂ H ₂₁ NO ₃	<i>N</i> -Ethyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	17.1	(2212)
C ₁₃ H ₁₉ NO ₂	<i>N</i> -Allylcamphorimide.....	Me ₂ CO	2.3	20	7.95	(2212)
C ₁₃ H ₂₁ NO ₃	<i>N</i> -Allyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	13.54	(2212)
C ₁₃ H ₂₁ NO ₂	<i>n</i> -Propylcamphorimide.....	Me ₂ CO	2.3	20	10.9	(2212)
C ₁₃ H ₂₃ NO ₃	<i>N-n</i> -Propyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	18.45	(2212)
C ₁₄ H ₂₃ NO ₂	<i>N-n</i> -Butylcamphorimide.....	Me ₂ CO	2.3	20	12.8	(2212)
C ₁₄ H ₂₅ NO ₃	<i>N</i> -Diethyl-α-camphoramic acid.....	EtOH	8.78	20	19.29	(685)
C ₁₄ H ₂₅ NO ₃	<i>N-β</i> -Butyl-α-camphoramic acid.....	EtOH	6.98	20	28.80	(685)
C ₁₄ H ₂₅ NO ₃	β- <i>n</i> -Butyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	15.8	(2212)
C ₁₅ H ₂₅ NO ₂	<i>N-n</i> -Amylcamphorimide.....	Me ₂ CO	2.3	20	7.7	(2212)
C ₁₅ H ₂₇ NO ₃	<i>N-n</i> -Amyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	18.9	(2212)
C ₁₆ H ₁₈ BrNO ₂	<i>N</i> -2-Bromophenylcamphorimide.....	Me ₂ CO	2.3	20	13.3	(2212)
	<i>N</i> -3-Bromophenylcamphorimide.....	Me ₂ CO	2.3	20	15.4	
	<i>N</i> -4-Bromophenylcamphorimide.....	Me ₂ CO	2.3	20	15.7	
C ₁₆ H ₁₈ ClNO ₂	<i>N</i> -2-Chlorophenylcamphorimide.....	Me ₂ CO	2.3	20	14.1	(2212)
	<i>N</i> -3-Chlorophenylcamphorimide.....	Me ₂ CO	2.3	20	16.2	
	<i>N</i> -4-Chlorophenylcamphorimide.....	Me ₂ CO	2.3	20	16.2	
C ₁₆ H ₁₈ N ₂ O ₄	<i>N</i> -3-Nitrophenylcamphorimide.....	Me ₂ CO	2.3	20	1.7	(2212)
C ₁₆ H ₁₉ BrN ₂ O ₄	<i>N</i> -4-Bromo-3-nitrophenyl-α-camphoramic acid.....	EtOH	1.50		−48.4	(2211)
C ₁₆ H ₂₀ BrNO ₃	<i>N</i> -4-Bromophenyl-α-camphoramic acid.....	EtOH	2.77		47.0	(211)
C ₁₆ H ₂₀ BrNO ₃	<i>N</i> -2-Bromophenyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	−11.8	(2212)
	<i>N</i> -3-Bromophenyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	33.2	
	<i>N</i> -4-Bromophenyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	37.8	
C ₁₆ H ₂₀ ClNO ₃	<i>N</i> -2-Chlorophenyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	−16.4	(2212)
	<i>N</i> -3-Chlorophenylcamphoramic acid.....	Me ₂ CO	2.3	20	37.0	
	<i>N</i> -4-Chlorophenylcamphoramic acid.....	Me ₂ CO	2.3	20	40.5	
C ₁₆ H ₂₀ N ₂ O ₅	<i>N</i> -3-Nitrophenyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	32.0	(2212)
C ₁₆ H ₂₁ BrN ₂ O ₄	<i>N</i> -4-Bromo-3-aminophenyl-α-camphoramic acid.....	EtOH	1.96		40.7	(2211); cf. (2212)
C ₁₆ H ₂₁ NO ₄	<i>N</i> -4-Hydroxyphenyl-α-camphoramic acid....	Me ₂ CO	2.3	20	49.2	(2212)
	<i>N-cis</i> -Hydroxyphenyl-α-camphoramic acid..			16	46.36	(1197)
	<i>N-trans</i> -Hydroxyphenyl-α-camphoramic acid			16	13.48	(1197)
C ₁₆ H ₂₂ N ₂ O ₃	<i>N</i> -3-Aminophenyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	39.9	(2212)
C ₁₆ H ₂₇ NO ₂	<i>N-n</i> -Hexylcamphorimide.....	Me ₂ CO	2.3	20	10.8	(2212)
C ₁₆ H ₂₉ NO ₃	<i>N-n</i> -Hexyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	16.9	(2212)
C ₁₇ H ₂₁ NO ₂	<i>N-o</i> -Tolylcamphorimide.....	Me ₂ CO	2.3	20	15.7	(2212)
	<i>N-m</i> -Tolylcamphorimide.....	Me ₂ CO	2.3	20	17.6	
	<i>N-p</i> -Tolylcamphorimide.....	Me ₂ CO	2.3	20	12.7	
C ₁₇ H ₂₃ NO ₃	<i>N-o</i> -Tolyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	33.9	(2212)
	<i>N-m</i> -Tolyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	31.0	
	<i>N-p</i> -Tolyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	37.0	
C ₁₇ H ₂₄ N ₂ O ₃	α-Methyl β-phenylhydrazinocamphorate....	EtOH		26	42.01	(807)
C ₁₈ H ₂₃ NO ₃	<i>N</i> -4-Ethoxyphenylcamphorimide.....	Me ₂ CO	2.3	20	18.5	(2212)
C ₁₈ H ₂₅ NO ₄	<i>N</i> -4-Ethoxyphenyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	39.5	(2212)
C ₁₈ H ₃₃ NO ₃	<i>N-d</i> -Octyl-α-camphoramic acid.....	EtOH	6.49	20	24.45	(685)
C ₂₀ H ₂₁ NO ₂	<i>N-α</i> -Naphthylcamphorimide.....	Me ₂ CO	2.3	20	26.34	(2212)
	<i>N-β</i> -Naphthylcamphorimide.....	Me ₂ CO	2.3	20	18.0	
C ₂₀ H ₂₃ NO ₃	<i>N-α</i> -Naphthyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	7.46	(2212)
	<i>N-β</i> -Naphthyl-α-camphoramic acid.....	Me ₂ CO	2.3	20	64.9	
C ₂₀ H ₂₈ N ₂ O ₃	β-Camphornitrilic acid anhydride ((CN.C ₈ H ₁₄ .CO) ₂ O).....	CHCl ₃	1.017		52.4	(608)
C ₂₂ H ₂₆ N ₃ O ₃	<i>N</i> -4-Benzeneazophenyl-α-camphoramic acid (C ₆ H ₅ .N ₂ .C ₆ H ₄ .NH.CO.C ₈ H ₁₄ .COOH).....	EtOH	2.3	20	87.7	(2212); cf. (2211)
C ₃₆ H ₄₇ Cl ₃ N ₄ O ₆	Trichlorobutylidenebis-3-aminophenyl-α-camphoramic acid (CH ₃ .C.Cl ₂ .CHCl.CH-(NH.C ₆ H ₄ .NH.CO.C ₈ H ₁₄ .COOH) ₂).....	Me ₂ CO	2.555		27.4	(2212)

Formula	Name	Solvent	d, C or %	t, °C	[α] _D	Lit.
C ₁₀ H ₁₄ BrNO ₃	β-Bromocamphoryloxime.....	CHCl ₃	2.20	13	10.2	(1286.5)
C ₁₀ H ₁₆ NO ₃	Camphoryloxime $\left(\text{C}_8\text{H}_{14} \begin{array}{c} \diagup \text{CO} \diagdown \\ \diagdown \text{CO} \diagup \end{array} \text{NOH} \right)$	C ₂ H ₄ Cl ₂	44.32	17.4	14.09	(1599)
		EtOH	1.8		10	(277)
C ₁₂ H ₁₄ NO ₄	Acetylcamphoryloxime.....	EtOH	2		4.25	(277)
C ₁₂ H ₁₆ BrNO ₄	Acetyl-β-bromocamphoryloxime.....	Me ₂ CO	2.36	15	3	(1286.5)
	Acetyl-π-bromocamphoryloxime.....	Me ₂ CO	51.4	13	1.3	
C ₁₇ H ₁₈ BrNO ₄	Benzoyl-β-bromocamphoryloxime.....	Me ₂ CO	1.57	12	11	(1286.5)
	Benzoyl-π-bromocamphoryloxime.....	Me ₂ CO	3.4	13	46.3	
C ₂₀ H ₂₈ N ₂ O ₆	Camphoryloxime anhydride.....	Me ₂ CO	2	14	26.7	(1286.5)
C ₃₀ H ₄₂ N ₂ O ₈	sesqui-Camphorylhydroxylamine.....	Me ₂ CO	3.22	13	33	(1286.5)
C ₁₆ H ₁₉ N ₃ O ₃	N-Nitrosocamphoryl phenylhydrazide.....	CHCl ₃	1.71		14.1	(2211)
C ₁₆ H ₁₉ N ₃ O ₄	N-Nitrocacphoryl phenylhydrazide.....	CHCl ₃	1.43		16.1	(2211)
C ₁₆ H ₁₉ BrN ₂ O ₂	Camphoryl 4-bromophenylhydrazide*.....	EtOH	0.981		26.9	(2211)
C ₁₆ H ₁₇ Br ₂ N ₃ O ₃	N-Nitrosocamphoryl dibromophenyl- hydrazide.....	CHCl ₃	1.11		19.0	(2211)
C ₁₆ H ₁₇ Br ₂ N ₃ O ₄	N-Nitrocacphoryl dibromophenyl- hydrazide.....	CHCl ₃	2.1		10.9	(2211)
C ₁₆ H ₁₈ BrN ₃ O ₃	N-Nitrosocamphoryl 4-bromophenyl- hydrazide.....	CHCl ₃	1.55		18.1	(2211)
C ₁₆ H ₁₈ BrN ₃ O ₄	N-Nitrocacphoryl 4-bromophenyl- hydrazide.....	CHCl ₃	1.72		14.0	(2211)
<i>Homocamphoric acid and esters</i>						
C ₁₂ H ₂₀ O ₄	α-Methylhomocamphoric acid.....	EtOH			26.31	(1432)
	β-Methylhomocamphoric acid.....	EtOH			38.12	
C ₁₃ H ₂₂ O ₄	α-Ethyl hydrogen homocamphorate.....	EtOH	4.18	17	55.8	(1553)
C ₁₃ H ₂₂ O ₄	Ethyl-β-homocamphoric acid.....	EtOH			39.65	(1433)
C ₁₉ H ₂₆ O ₄	α-Ethyl β-phenylhomocamphorate.....	EtOH	9.64	19	27.58	(1553)
<i>Other dicarboxylic acids</i>						
C ₉ H ₁₂ O ₃	Caryophyllenic anhydride.....		1.1399 ²⁰	20	-28	(1928)
C ₁₀ H ₁₆ O ₄	d-Homotanacetonedicarboxylic acid†.....	MeOH	20		10.25	(1920)
C ₁₁ H ₁₈ O ₄	Methyl caryophyllenate.....		1.0456	20	44	(1928)
AMINES AND IMINES						
MONOAMINES AND HYDROXYAMINES						
C ₁₀ H ₁₇ N	1-Aminocamphene.....	EtOH	1.78	22	59.7	(578)
		C ₆ H ₆	1.93	22	43.4	
C ₁₀ H ₁₇ N	Camphenamine.....	MeOH	15.7	18	4.11	(398)
C ₁₀ H ₁₉ N	Camphidine.....	C ₆ H ₆	10	20	23.9	(1997)
C ₁₁ H ₂₃ NO	α-Aminohomocampholic alcohol.....	C ₆ H ₆	0.93	21	68.71	(1553)
		EtOH	5.03	15	78.86	
KETOAMINES AND IMINES						
<i>Iminocamphor and derivatives</i>						
C ₁₀ H ₁₆ NO ₂	α-Iminocamphor $\left(\text{C}_8\text{H}_{14} \begin{array}{c} \diagup \text{C: NH} \diagdown \\ \diagdown \text{CO} \diagup \end{array} \right)$	EtOH	1.67		77.8	(593)
C ₁₆ H ₁₈ BrNO	o-Bromophenyliminoeamphor.....	CHCl ₃	0.191	31	429.4†	(1952)
		MeOH	0.182	31.5	327.2†	
	m-Bromophenyliminoeamphor.....	CHCl ₃	0.700	31	415.5†	
		MeOH	0.734	31	336.7†	
	p-Bromophenyliminoeamphor.....	CHCl ₃	0.612	30	534.0†	
		MeOH	0.600	30	280.2†	
C ₁₆ H ₁₈ ClNO	o-Chlorophenyliminoeamphor.....	CHCl ₃	0.318	28.0	161.9†	(1952)
		MeOH	0.473	31.0	176.6†	
	m-Chlorophenyliminoeamphor.....	CH				



‡ Mutarotation.

Iminocamphor and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₆ H ₂₀ N ₂ O	Phenyliminocamphor-α-oxime.....	CHCl ₃	1.043		304.4	(608)
	Phenyliminocamphor-β-oxime.....	CHCl ₃	1.058		335.4	
C ₁₇ H ₂₁ NO	<i>o</i> -Tolyliminocamphor.....	CHCl ₃	0.739	32	464.4*	(1952)
		MeOH	0.764	34	398.4*	
	<i>m</i> -Tolyliminocamphor.....	CHCl ₃	0.326	29.5	660.7*	
		MeOH	0.454	29.5	689.7*	
	<i>p</i> -Tolyliminocamphor.....	MeOH	0.795	30	474.5*	
			0.321	28	228.9*	(1952)
C ₁₇ H ₂₁ NO ₂	<i>o</i> -Methoxyphenyliminocamphor.....	CHCl ₃	0.388		1223	(611)
	<i>p</i> -Methoxyphenyliminocamphor.....	CHCl ₃	0.340	32.0	609.6	(1952)
C ₂₀ H ₂₁ NO	α-Naphthyliminocamphor.....	CHCl ₃	0.603	32.0	558.5	
		MeOH	0.485	31.0	686.0	
	β-Naphthyliminocamphor.....	MeOH	0.573		641.6	
			0.843	18	393.2	(1952)
C ₂₀ H ₂₅ NO	<i>ar</i> -Tetrahydro-α-naphthyliminocamphor....	MeOH	0.808	18	450.9	
		CHCl ₃	0.280	23.5	580.8	(1952)
C ₂₂ H ₂₃ N ₃ O	<i>p</i> -Benzeneazophenyliminocamphor.....	CHCl ₃	0.180		568.4	
		MeOH	1.038		314.6	(608)
C ₂₃ H ₂₄ N ₂ O ₂	Benzoylphenyliminocamphor-α-oxime.....	CHCl ₃	1.059		308.4	
	Benzoylphenyliminocamphor-β-oxime.....	CHCl ₃				
C ₂₃ H ₂₆ N ₃ O ₂	Phenyliminocamphor-α-oxime-phenylurethane.....	CHCl ₃	0.975		207.7	(608)
	Phenyliminocamphor-β-oxime-phenylurethane.....	CHCl ₃	8.866		184.7	
	<i>m</i> -Phenylenebisiminocamphor.....	MeOH	0.097	30.5	634.1	(1952)
		CHCl ₃	0.395	28.0	671.0	
C ₂₆ H ₃₂ N ₂ O ₂	<i>p</i> -Phenylenebisiminocamphor.....	CHCl ₃	0.624		1509	(611)
		CHCl ₃	0.143	24.5	1507	(1953)
		MeOH	0.178	21.7	1240	
		EtOH	0.132	21.7	1309	
			0.033	20	333.3	(1954)
C ₂₇ H ₃₄ N ₂ O ₂	<i>m</i> -Tolylenebisiminocamphor.....	CHCl ₃	0.034	20	248.5	
		MeOH	0.0533	18.1	1801	(1953)
		MeOH	0.0181	18.4	1994	
		EtOH	0.0168	18.4	2696	
C ₃₀ H ₃₄ N ₂ O ₂		Py	0.0244	30	2955	
	<i>p</i> , <i>p'</i> -Diphenylenebisiminocamphor (green form).....	CHCl ₃	0.257	35	1140	(1955)
	(yellow form).....	CHCl ₃	0.473	35	1132	
		MeOH	0.908	29	1046	
	<i>p</i> , <i>p'</i> -Bisiminocamphordiphenylamine.....	CHCl ₃	0.130	23	2300	(1955)
C ₃₂ H ₃₇ N ₃ O ₂		CHCl ₃	0.0364	30	2370	
		MeOH	0.0554	23	2500	
		Me ₂ CO	0.0376	19	2646	
		EtOH	0.0440	19	2875	
		Py	0.1084	30	2685	
	<i>o</i> , <i>o'</i> -Ditolylenebisiminocamphor (green isomeride).....	CHCl ₃	0.128	29	773	(1955)
		MeOH	0.115	30	645	
C ₃₄ H ₄₀ N ₂ O ₂	(yellow isomeride).....	CHCl ₃	0.564	29	789	
		Me ₂ CO	0.271	21	736	
		MeOH	0.0834	29	683	
	<i>o</i> , <i>o'</i> -Dimethoxydiphenylenebisiminocamphor.....	CHCl ₃	0.167	22	371	(1955)
C ₃₄ H ₄₀ N ₂ O ₄		MeOH	0.264	22	290	
<i>Derivatives of aminocamphor</i>						
C ₁₀ H ₁₄ N ₂ O	Diazocamphor.....	CHCl ₃	1.642		134.8	(614)
C ₁₀ H ₁₆ N ₃ O	Camphorylazoimide.....	C ₆ H ₆	1.04		-351.5	(593)
		EtOH	1.04		-284.2	
		Me ₂ CO	1.045		-279.4	
		CHCl ₃	1.035		-246.2	
C ₁₀ H ₁₈ N ₂ O	α-Aminocamphoroxime.....	EtOH	1	18	60.5	(1173)
C ₁₀ H ₁₉ ClN ₂ O	α-Aminocamphoroxime hydrochloride.....	H ₂ O	1	16	36.7	(1173)

* Mutarotation.

Derivatives of aminocamphor.—(Continued)

Formula	Name	Solvent	d , C or %	t , °C	$[\alpha]_D$	Lit.
$C_{10}H_{19}N_3$	Aminocamphorhydrazone.....	$CHCl_3$	0.966		250.2	(604)
$C_{16}H_{21}NO_3S$	Benzenesulfonylaminocamphor.....	$CHCl_3$	0.993		85.6	(604)
$C_{16}H_{23}N_3$	Aminocamphorphenylhydrazone.....	$CHCl_3$	0.951		176.2	(604)
$C_{17}H_{23}NO_3S$	Benzenesulfonylmethylaminocamphor.....	$CHCl_3$	1.026		85.3	
$C_{17}H_{23}NO_3S$	<i>p</i> -Toluenesulfonylaminocamphor*.....	$CHCl_3$	1.069		87.3	(604)
$C_{18}H_{26}NO_3S$	<i>p</i> -Toluenesulfonylmethylaminocamphor.....	$CHCl_3$	1.021		81.6	(604)
$C_{20}H_{31}NO_4S$	Camphor- β -sulfonylaminocamphor†.....	$CHCl_3$	1.037		-35.2	(604)
$C_{24}H_{26}N_2O_3$	Dibenzoylaminocamphoroxime‡.....	EtOH	1.33	18	104.8	(1173)
<i>Anilinocamphor and derivatives</i>						
$C_{16}H_{20}BrNO$	<i>o</i> -Bromophenylaminocamphor.....	$CHCl_3$	0.203	19	76.3	(1952)
		MeOH	0.140	19	71.1	
	<i>m</i> -Bromophenylaminocamphor.....	$CHCl_3$	2.842	19	86.2	
		MeOH	0.162	19	64.6	
	<i>p</i> -Bromophenylaminocamphor.....	$CHCl_3$	0.267	19	93.5§	
		MeOH	0.180	19	67.8§	
$C_{16}H_{20}ClNO$	<i>p</i> -Chlorophenylaminocamphor.....	$CHCl_3$	0.093		694	(611)
$C_{16}H_{21}NO$	Phenylaminocamphor.....	$CHCl_3$	0.090		127	(611)
$C_{16}H_{21}NO_2$	<i>p</i> -Hydroxyphenylaminocamphor.....	$CHCl_3$	0.0978		83	(611)
$C_{17}H_{23}NO$	<i>o</i> -Tolylaminocamphor.....	MeOH	0.221	17	58.9§	(1952)
		$CHCl_3$	0.280	17	85.7§	
	<i>m</i> -Tolylaminocamphor.....	MeOH	0.323	17	83.7§	
		$CHCl_3$	0.254	17	128.7§	
	<i>p</i> -Tolylaminocamphor.....	MeOH	0.244	18	57.5§	
		$CHCl_3$	0.272	17	99.2§	
$C_{17}H_{23}NO_2$	<i>o</i> -Methoxyphenylaminocamphor.....	MeOH	1.171	20	53.6	(1952)
		$CHCl_3$	1.159	20	99.7	
$C_{17}H_{23}NO_2$	<i>p</i> -Methoxyphenylaminocamphor.....	$CHCl_3$	0.092		68	(611)
$C_{18}H_{26}N_2O_3$	<i>p</i> -Ethoxyphenylaminocamphor (hydroxy- amino derivative).....	$CHCl_3$	1.104		101.8	(611)
$C_{20}H_{23}NO$	α -Naphthylaminocamphor.....	$CHCl_3$	1.404	18	91.3	(1952)
		MeOH	1.540	16.8	71.77	
	β -Naphthylaminocamphor.....	$CHCl_3$	0.284	18	142.6	
		MeOH	0.284	18	125.0	
$C_{20}H_{27}NO$	<i>ar</i> -Tetrahydro- α -naphthylaminocamphor....	MeOH	0.275	20	109.5	(1952)
		$CHCl_3$	0.407	20	117.1	
$C_{26}H_{36}N_2O_2$	<i>m</i> -Phenylenebisaminocamphor.....	$CHCl_3$	0.126	20	151.2	(1952)
		MeOH	0.114	20	118.3	
$C_{27}H_{38}N_2O_2$	<i>m</i> -Tolylenebisaminocamphor.....	$CHCl_3$	0.161	20	83.9	(1952)
		MeOH	0.177	20	91.6	
$C_{32}H_{40}N_2O_2$	<i>p</i> , <i>p'</i> -Diphenylenebisaminocamphor.....	$CHCl_3$	0.292	17	97.6	(1955)
		MeOH	0.065	17	76.9	
		Me_2CO	0.144	17	163.7	
<i>Camphorylcarbamide, carbimide and carbamic acid with isomers and derivatives</i>						
$C_{11}H_{16}NO_2$	Camphorylcarbimide 	$CHCl_3$	1.90		-124.5	(591)
$C_{11}H_{16}NOS$	Camphorylthiocarbimide.....	EtOH	0.907		-114.1	(600)
$C_{11}H_{16}Br_2N_2O_2$	Camphoryl- <i>N</i> -dibromo- ψ -carbamide.....	$CHCl_3$	0.973		30.9	(597)
$C_{11}H_{16}Cl_2N_2O_2$	Camphoryl- <i>N</i> -dichloro- ψ -carbamide¶.....	$CHCl_3$	0.54		26.5	(597)
$C_{11}H_{17}NOS_2$	Camphoryldithiocarbamic acid**.....	Me_2CO	1.05		21.5	(600)
$C_{11}H_{17}N_3O_3$	Camphorylnitroso- ψ -carbamide.....	$CHCl_3$	1.26		169.3	(591)
$C_{11}H_{18}N_2O_2$	Camphoryl- ψ -carbamide††.....	EtOH	1.84		-13.5	(591)
$C_{11}H_{18}N_2OS$	Camphorylthiocarbamide ($C_{10}H_{16}O.NH.CS.NH_2$).....	$CHCl_3$	1.06		-44.9	(600)
$C_{12}H_{19}BrN_2O_2$	Camphorylmethylbromo- ψ -carbamide.....	$CHCl_3$	1.31		9.5	(597)
$C_{12}H_{19}NO_3$	Methyl camphorylcarbamate ($C_{10}H_{16}O.NH.CO.OCH_3$).....	$CHCl_3$	1.03		43.5	(591)
$C_{12}H_{19}NOS_2$	Methyl camphoryldithiocarbamate‡‡.....	$CHCl_3$	4.18		114.6	(600)
$C_{12}H_{19}NO_2S$	Methyl camphorylthiocarbamide.....	$CHCl_3$	1.46		108.6	(600)
$C_{12}H_{20}N_2O_2$	Camphorylmethyl- ψ -carbamide.....	EtOH	3.25		6.9	(591)
$C_{13}H_{21}NO_3$	Ethyl camphorylcarbamate§§.....	$CHCl_3$	2.1		38.3	(591)
$C_{16}H_{26}N_2OS$	Camphorylpiperidylthiocarbamide.....	$CHCl_3$	1.25		26.6	(600)

* $C_{10}H_{16}O.NH.SO_2.C_6H_4.CH_3$.† $C_{10}H_{16}O.NH.SO_2.C_{10}H_{15}O$.‡ C_6H_5 $\begin{array}{c} CH.N(COC_6H_5)_2 \\ | \\ C:NOH \end{array}$.

§ Mutarotation.

|| C_6H_5 $\begin{array}{c} CH.NCO \\ | \\ CO \end{array}$.¶ C_6H_5 $\begin{array}{c} CH.NCl.CO \\ | \\ C(OH)-NCl \end{array}$.** $C_{10}H_{16}O.NH.CS.SH$.†† C_6H_5 $\begin{array}{c} CH.NH.CO \\ | \\ C(OH).NH \end{array}$.‡‡ $C_{10}H_{16}O.NH.CS.S.CH_3$.§§ $C_{10}H_{16}O.NH.CO.O.C_2H_5$.

Camphorylcarbamide, carbimide and carbamic acid with isomers and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₅ H ₂₇ N ₂ O ₂	<i>s</i> -Camphorylpiperidylcarbamide*.....	CHCl ₃	1.60		40.1	(591)
C ₁₇ H ₂₂ N ₂ O ₂	Camphoryl phenyl-ψ-carbamide.....	CHCl ₃			12.4	(595)
C ₁₈ H ₂₁ NO ₂ S ₂	Benzoylcamphoryldithiocarbamic acid.....	CHCl ₃	1.15		52.3	(600)
C ₂₁ H ₃₂ N ₂ O ₂	Bornylcarbiminocamphor.....	CHCl ₃	1.33		153.8	(593)
		C ₆ H ₆	1.19		131.8	
		Me ₂ CO	1.40		121.0	
		EtOH	0.95		108.7	
C ₂₁ H ₃₂ N ₂ O ₃	<i>s</i> -Dicamphorylcarbamide.....	CHCl ₃	2.08		38.2	(591)
C ₂₁ H ₃₂ N ₂ O ₂ S	Dicamphorylthiocarbamide (CS.(NH.C ₁₀ H ₁₅ O) ₂).....	Me ₂ CO	1.93		54.3	(600)
C ₂₃ H ₂₆ N ₄ O ₂	Camphordiazodiphenylcarbamide.....	Py	0.5		211.4†	(595)
<i>Camphorylsemicarbazide, isomers and derivatives</i>						
C ₁₁ H ₁₇ N ₃ O	Camphoryl-ψ-semicarbazide anhydride.....	CHCl ₃	0.505		−186.2	(592)
C ₁₁ H ₁₉ N ₃ O ₂	Camphoryl-ψ-semicarbazide‡.....	H ₂ O	3.38		8.6	(592)
C ₁₁ H ₂₀ N ₄ O ₂	Camphorylsemicarbazide oxime§ (1st isomeride).....	Py	0.410		81.3	(594)
	(2nd isomeride).....	Py	0.405		−37.7	
C ₁₄ H ₂₃ N ₃ O ₂	<i>N</i> -Isopropylidene camphoryl-ψ-semi- carbazone.....	CHCl ₃	0.441		−187.8	(592)
C ₁₅ H ₂₁ N ₃ O ₃	<i>N</i> -Furfurylidene camphoryl-ψ-semi- carbazone.....	CHCl ₃	0.402		502.2	(592)
		EtOH	0.922		100.5	
C ₁₆ H ₂₂ N ₄ O ₃	<i>N</i> -Furfurylidenesemicarbazinocamphor- oxime.....	CHCl ₃	1.32		120.8	(594)
C ₁₇ H ₂₁ N ₃ O ₃	<i>N</i> -Benzoquinone camphoryl-ψ-semicarbazone	Py	0.51		−1051	(592)
		Me ₂ CO	0.135		−1051	
		CHCl ₃	0.033		−1067	
		EtOH	0.093		−545	
C ₁₇ H ₂₂ BrN ₅ O ₂ .½EtOH	<i>N</i> - <i>p</i> -Bromobenzenediazo-ψ-semicarbazino- camphor.....	EtOH	1.09		180.3	(588)
C ₁₇ H ₂₂ ClN ₅ O ₂	<i>N</i> - <i>p</i> -Chlorobenzenediazo-ψ-semicarbazino- camphor.....	EtOH	0.389		212.2	(588)
C ₁₇ H ₂₃ N ₅ O ₂	<i>N</i> -Benzenediazo-ψ-semicarbazinocamphor..	EtOH	1.2		235.8	(588)
C ₁₇ H ₂₃ N ₃ OS	δ-Camphoryl β-phenylthiosemicarbazide...	CHCl ₃	1.26		59.5	(600)
	δ-Camphoryl α-phenylthiosemicarbazide...	CHCl ₃	0.85		58.5	
C ₁₈ H ₂₂ N ₄ O ₄	<i>N</i> - <i>m</i> -Nitrobenzylidene camphoryl-ψ-semi- carbazone.....	Py	0.808		20.4	(592)
		AcOH	1.13		84.1	
C ₁₈ H ₂₂ N ₃ O ₂	<i>N</i> -Benzylidene camphoryl-ψ-semicarbazone.	CHCl ₃	2.01		420.6	(592)
C ₁₈ H ₂₃ N ₃ O ₃	<i>N</i> - <i>o</i> -Hydroxybenzylidene camphorylsemi- carbazone.....	CHCl ₃	1.65		276.8	(592)
C ₁₈ H ₂₃ N ₅ O ₄	<i>N</i> - <i>m</i> -Nitrobenzylidenesemicarbazino- camphoroxime.....	CHCl ₃	0.547		126.5	(594)
C ₁₈ H ₂₄ N ₄ O ₂	<i>N</i> -Benzylidenesemicarbazinocamphoroxime.	CHCl ₃	1.04		110.1	(594)
C ₁₈ H ₂₅ N ₅ O ₂	<i>N</i> - <i>p</i> -Toluenediazo-ψ-semicarbazinocamphor.	EtOH	1.39		222.2	(588)
C ₁₉ H ₂₃ N ₃ O ₄	<i>N</i> -Piperonylidene camphoryl-ψ-semi- carbazone.....	CHCl ₃	1.21		450.0	(592)
C ₁₉ H ₂₅ N ₃ O ₃	<i>N</i> - <i>p</i> -Methoxybenzylidene camphorylsemi- carbazone.....	CHCl ₃	1.96		440.2	(592)
C ₁₉ H ₂₅ N ₃ O ₄	<i>N</i> -Vanillylidene camphoryl-ψ-semicarbazone	CHCl ₃	0.918		308.6	(592)
C ₂₀ H ₂₅ N ₃ O ₂	<i>N</i> -Cinnamylidene camphoryl-ψ-semi- carbazone.....	CS ₂	0.705		330.7	(592)
		CHCl ₃	1.04		514.4	
		Me ₂ CO	0.804		161.6	
		Py	0.886		−53.7	
C ₂₁ H ₂₉ N ₃ O ₂	<i>N</i> -Cuminylidene camphoryl-ψ-semicarbazone	CHCl ₃	1.20		415	(592)
C ₂₁ H ₃₁ N ₃ O ₃	<i>N</i> -Camphorquinone camphoryl-ψ-semi- carbazone.....	CHCl ₃	0.942		−314.2	(592)
C ₂₅ H ₂₅ N ₉ O ₃	Bis- <i>p</i> -triazobenzoin camphoryl-ψ-semi- carbazone.....	CHCl ₃	0.698		556.3	(603)
		Py	1.0400		24.0	

* C₁₀H₁₅O.NH.CO.NC₆H₁₀.

† Mutarotation.

‡ C₆H₁₁ $\begin{array}{c} \text{CH.N.NH}_2 \\ | \\ \text{COH—NH} \end{array}$ CO.§ C₆H₁₁ $\begin{array}{c} \text{CH.NH.NH.CO.NH}_2 \\ | \\ \text{C: NOH} \end{array}$.

Amino derivatives of epicamphor

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₀ H ₁₇ NO	Amino- <i>l</i> -epicamphor.....	EtOH	1.052		11.9	(608)
		C ₆ H ₆	5.90	19	15.0	(237)
C ₁₀ H ₁₈ N ₂ O	Aminoepicamphoroxime.....	CHCl ₃	1.248		-20.0	(608)
C ₁₇ H ₂₁ NO	Benzylideneaminoepicamphor.....	CHCl ₃	0.410		298.5	(608)
C ₁₇ H ₂₁ NO ₂	Benzoylaminoepicamphor.....	CHCl ₃	1.411		-24.2	(608)
C ₁₇ H ₂₃ NO ₃ S	<i>p</i> -Toluenesulfonylaminoepicamphor.....	CHCl ₃	1.00		-16.6	(604)
C ₂₄ H ₂₆ N ₂ O ₃	Dibenzoylaminoepicamphoroxime.....	CHCl ₃	0.972		-36.8	(608)
C ₃₂ H ₃₆ N ₈ O ₁₄	Aminoepicamphoroximeepidihydro- dicamphenepyrazine picrate.....	EtOH	0.492		250.9	(608)
<i>Amino derivatives of methylenecamphor and benzylidenecamphor</i>						
C ₁₇ H ₂₁ NO	Anilino- <i>d</i> -methylenecamphor.....	C ₆ H ₆	1.703		293.6*	(1675)
C ₁₉ H ₂₆ NO	<i>d</i> - α -Phenylethylamino- <i>d</i> -methylenecamphor	C ₆ H ₆	0.788		-8.9*	(1675)
		EtOH	0.499		315.6*	
		AcOH	0.826		210.7*	
C ₁₉ H ₂₆ NO	<i>p</i> -Dimethylaminobenzylidenecamphor.....	EtOH	0.977	24	758	(804)
C ₁₉ H ₂₆ ClNO	<i>p</i> -Dimethylaminobenzylidenecamphor hydrochloride.....	H ₂ O	0.593	23	356	(804)
C ₂₁ H ₂₉ NO	<i>p</i> -Diethylaminobenzylidenecamphor.....	EtOH	0.990	19	740	(804)
C ₂₁ H ₃₀ ClNO	<i>p</i> -Diethylaminobenzylidenecamphor hydro- chloride.....	H ₂ O	0.486	23	321	(804)
AMINO ACIDS						
C ₉ H ₁₅ NO	Aminodihydrocampholytic anhydride†.....	ligroin	10	30	72.8	(1528)
C ₁₀ H ₁₆ N ₂ O ₂	<i>N</i> -Nitroso- α -camphidone.....	EtOH	2.5	23	-59.0	(1528)
	<i>N</i> -Nitroso- β -camphidone.....	EtOH	2.5	23	103	
C ₁₀ H ₁₇ NO	α -Camphidone‡.....	EtOH	5	25	33.9	(1528)
		C ₆ H ₆	10	20	-37.2	(1997)
	β -Camphidone§.....	EtOH	5	24	63.2	(1528)
		C ₆ H ₆	10	20	66.5	(1997)
C ₂₀ H ₃₂ N ₂ O	Di- β -camphidone anhydride.....	C ₆ H ₆	10	20	207.4	(1996)
<i>Compounds of phosphorus, arsenic and antimony</i>						
C ₂₀ H ₃₁ O ₆ P	Dicamphorylphosphinic acid (C ₁₀ H ₁₅ O ₂) ₂ .PO.OH.....	CHCl ₃	2.3852	20	151.1	(1459)
C ₂₀ H ₃₁ AsO ₆	Dicamphorylarsinic acid ((C ₁₀ H ₁₅ O) ₂ AsO.OH).....	CHCl ₃	1.96	20	186.6	(1457)
C ₃₀ H ₄₅ Cl ₂ O ₃ Sb	Tricamphorylstibine chloride ((C ₁₀ H ₁₅ O) ₃ .SbCl ₂).....	CHCl ₃	1.248	20	367.3	(1458)

IIDCB. The Molecule Contains Three or More Asymmetric Atoms Attached Respectively to Two, Three and Four Other Carbon Atoms

HYDROCARBONS AND HALOGEN DERIVATIVES

C ₁₀ H ₁₇ Cl	Fenchyl chloride.....	EtOH	11.79		17.98	(1130); cf. (1127)
C ₁₀ H ₁₇ Cl	Bornyl chloride.....	CCl ₄	68.27	17.4	6.92	(1599)

ALCOHOLS

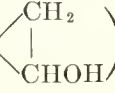
MONOHYDRIC ALCOHOLS

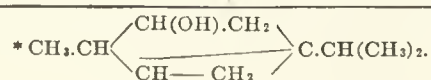
Fenchyl alcohol and derivatives

C ₁₀ H ₁₈ O	Fenchyl alcohol 	MeOH	5.135	20	-14.03	(306); cf. (780, 2110)
C ₁₀ H ₁₈ O	<i>d</i> -Isenfenchyl alcohol.....	EtOH	24.6	10.5	18.17	(1858)
	<i>L</i> - <i>d</i> -Fenchyl alcohol.....	EtOH	10.12	15.5	12.69	
C ₁₁ H ₂₀ O	Homofenchyl alcohol (methylfenchol).....	Et ₂ O	30.18	19	2.2	(2131)
C ₁₁ H ₂₀ O	Methylfenchyl alcohol.....	EtOH	2.45		11	(2231)
C ₁₂ H ₂₀ O ₂	Fenchyl acetate.....		0.972 ₁₆		-58.08	(125.1)
C ₁₆ H ₂₂ O	<i>tert</i> -Phenylfenchol.....	EtOH		18	45.65	(1199)
C ₁₇ H ₂₄ O	<i>tert</i> - <i>o</i> -Tolylfenchol.....	EtOH		18	23.23	(1199)
	<i>tert</i> - <i>p</i> -Tolylfenchol.....	EtOH			16.30	
	<i>tert</i> -Benzylfenchol.....	EtOH		15	24.20	
C ₂₂ H ₃₈ CrO ₄	Dimethylfenchyl chromate.....	CCl ₄	10		-30.0¶	(2177)
C ₂₄ H ₄₂ CrO ₄	Diethylfenchyl chromate.....	CCl ₄	4		22.5¶	(2177)
C ₃₀ H ₄₂ O ₂	Fenchyl triphenylacetate.....	PhMe	13.24	20	-17.30	(315)

* Mutarotation. † $\text{C}_8\text{H}_{14} \begin{array}{c} \text{NH} \\ \diagup \quad \diagdown \\ \text{CO} \end{array}$. ‡ $\text{C}_8\text{H}_{14} \begin{array}{c} \text{CO} \\ \diagup \quad \diagdown \\ \text{CH}_2 \end{array} \text{NH}$. § $\text{C}_8\text{H}_{14} \begin{array}{c} \text{CH}_2 \\ \diagup \quad \diagdown \\ \text{CO} \end{array} \text{NH}$. || $\begin{array}{c} \text{CH}_2-\text{CH}-\text{C}(\text{CH}_3)_2 \\ | \quad | \\ \text{CH}_2 \quad | \\ | \quad | \\ \text{CH}_2-\text{C}(\text{CH}_3)-\text{CHOH} \end{array}$. ¶ $[\alpha]_{587.0}$.

Thujyl alcohol and derivatives

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₀ H ₁₈ O	Thujol*			20	67.80	(306)
	α-Thujyl alcohol		0.925	20	69.82	(1555,
	β-Thujyl alcohol		0.9229	16	114.67	1556)
C ₁₁ H ₂₀ O	<i>l</i> -Thujyl alcohol	PhMe	35.98	20	−9.12	(313)
	<i>d</i> -Thujyl alcohol		0.9187	20	116.93	
	<i>tert.</i> -Homothujyl alcohol (solid isomeride)	Et ₂ O	4.058	15.5	−30.5	(2022)
		MeOH	4.191	12.0	−26	
	(liquid isomeride)	Et ₂ O	5.226	14	35.9	
C ₁₈ H ₂₂ O ₄		MeOH	5.077	13	33.4	
	β-Thujyl hydrogen phthalate	EtOH	1.096		91.45	(1556); <i>cf.</i> (1555)
C ₂₉ H ₄₄ N ₂ O ₆	Strychnine β-thujyl phthalate	C ₆ H ₆	1.766		36.78	(1556)
<i>Borneol with alkyl and alkylidene derivatives and ethers</i>						
C ₁₀ H ₁₈ O	<i>d</i> -Borneol (C ₈ H ₁₄ ); <i>cf.</i> (101, 787, 1034)	C ₂ H ₄ Cl ₂	23.73	15.8	35.22	(1599)
		EtOH	18	20	37.7	(1489)
		MeOH	20	9.98	36.37	(306)
	<i>l</i> -Borneol	PhMe	11.6		−37.96	(1629); <i>cf.</i> (1035, 787)
		<i>d</i> -Isoborneol; <i>cf.</i> (103.5, 784, 787, 790, 1034, 1446, 1449)	EtOH	5.13		34.02
C ₁₀ H ₁₈ S		PhMe	11.5		21.32	
		MeOH	9.98	20	32.30	(306)
	Thioborneol	AcOEt	3.64	15	21.08	(2222)
	β-Aminoborneol	MeOH	26.1	18	−42.47	(398)
	α-Isonitroso-β-methylborneol	CHCl ₃	2.35		84.2	(587)
C ₁₀ H ₁₉ NO	β-Isonitroso-β-methylborneol	CHCl ₃	2.1		67.8	
	γ-Isonitroso-β-methylborneol	CHCl ₃	1.30		45	
	Isobornyl methyl ether (from camphene).... (from camphene HCl)		0.9277 ₄ ²⁰	21	−14.82	(1411)
			0.9277 ₄ ²⁰	25	−23.4	
	C ₁₁ H ₂₀ O	Methylborneol	EtOH			30.79
C ₁₂ H ₁₉ Cl ₃ O ₂	Chloral borneol	C ₆ H ₆	15.07	15.5	30.13	(785)
C ₁₂ H ₁₉ Br ₃ O ₂	Bromal borneol	C ₆ H ₆	21.7	15.5	52.4	(1430)
C ₁₂ H ₂₂ O	Ethylborneol		0.9490 ⁰		26.3	(175)
		EtOH	26.3	18	36.98	(1281)
C ₁₃ H ₂₂ O	Bornyl allyl ether		0.9221 ₄ ²¹		−59.1	(814)
C ₁₃ H ₂₂ O	Allylborneol	EtOH	5.07	16	20.37	(1281)
C ₁₃ H ₂₄ O	Methylethylborneol	EtOH	3.04	14	39.02	(1281); <i>cf.</i> (813)
C ₁₄ H ₂₆ O	Isobutylborneol	EtOH			20.7	(823)
C ₁₄ H ₂₆ O	Diethylborneol	EtOH	2.32	18	51.62	(1281); <i>cf.</i> (813)
C ₁₆ H ₂₆ O	Diallylborneol	EtOH	2.79	18	78.77	(1281)
C ₁₇ H ₂₄ O	α-Benzylborneol		1.1325 ₄ ¹⁸		26.17	(802)
					−12.00	
C ₁₈ H ₂₂ O	Phenylethenylborneol	C ₆ H ₆	10	20	−27.37	(1828)
C ₁₈ H ₂₄ O	Dihydrophenylethenylborneol	C ₆ H ₆			−101.7	(1828)
C ₂₀ H ₂₇ NO ₂	Allylborneol phenylcarbamate	EtOH	8.25	16	19.38	(1281)
C ₂₁ H ₃₁ NO ₂	Diethylborneol phenylcarbamate	EtOH	5.78		42.05	(1281)
C ₂₄ H ₃₀ O	<i>l</i> -Dibenzylborneol	EtOH	2.54	19	−15.72	(1281); <i>cf.</i> (813)
<i>Borneol esters and carboxylates</i>						
C ₁₀ H ₁₇ Cl ₃ OSi	<i>l</i> -Bornyl trichlorosilicate (C ₁₀ H ₁₇ O.SiCl ₃)....		1.189	24.9	−20.09	(1597)
C ₁₁ H ₁₈ O ₂	<i>l</i> -Bornyl formate (C ₁₀ H ₁₇ O.CHO).....		1.0058	20	−40.46	(295)
C ₁₁ H ₁₈ O ₂	<i>d</i> -Bornyl formate		1.009 ₄ ²²		48.75	(106)
		EtOH	4.55		36.6	(1440)
C ₁₁ H ₁₉ NOS	Isobornyl formate					
	Bornylxanthamide (C ₁₀ H ₁₇ O.CS.NH ₂).....	C ₆ H ₆	6.41		18.95	(299)
C ₁₁ H ₁₈ O ₃	Epiborneolcarboxylic acid (isomeride A).... (isomeride B).... (isomeride D)....	AcOEt	4.65		2.36	(238)
		AcOEt	5.52		−4.8	
		AcOEt	0.693		77.9	

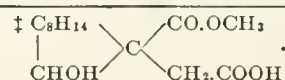
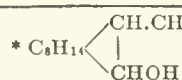


Borneol esters and carboxylates.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>c</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₂ H ₂₀ O ₂	<i>l</i> -Bornyl acetate.....	EtOH	19.6	15.5	44.97	(783)
			0.9855	20	-44.40	(295)
C ₁₃ H ₂₀ O ₃	Isobornyl acetate.....	EtOH	4.90		44.3	(1440)
	<i>l</i> -Bornyl pyruvate.....		1.0467	19.9	-52.4	(1352)
C ₁₃ H ₂₂ O ₂	<i>l</i> -Bornyl propionate.....		0.9717	20	-42.06	(295)
C ₁₃ H ₂₂ O ₂	Isobornyl propionate.....	EtOH	5.25		48.8	(1440)
C ₁₃ H ₂₂ O ₃	<i>l</i> -Bornyl <i>dl</i> -lactate.....		1.0370 ₄ ²⁰	20	-39.3	(1347)
C ₁₄ H ₂₀ O ₄		EtOH	5.26	20	-36.4	
	<i>l</i> -Bornyl hydrogen fumarate.....	CHCl ₃	6.79	12	-48.7	(1353)
C ₁₄ H ₂₂ O ₂		EtOH	4.05	11.5	-44.8	
	Bornyl crotonate; <i>cf.</i> (1434).....	EtOH	5.55		42.7	(1440)
C ₁₄ H ₂₂ O ₄	Bornyl hydrogen succinate.....	EtOH	25.4	15.5	35.59	(782)
C ₁₄ H ₂₄ O ₂	Bornyl butyrate.....	EtOH	5.6		-4.01	(1434)
C ₁₄ H ₂₄ O ₂			0.9611	20	-39.15	(295)
	Isobornyl butyrate.....	EtOH	5.60		50.6	(1440)
C ₁₄ H ₂₄ O ₃	Isobornyl isobutyrate.....	EtOH	5.60		47.7	
	<i>l</i> -Bornyl <i>dl</i> -α-hydroxybutyrate.....	EtOH	4.734	20	-34.5	(1347)
C ₁₅ H ₂₆ O ₂	Isobornyl valerate.....	EtOH	5.95		49.8	(1440)
C ₁₅ H ₂₆ O ₃	<i>l</i> -Bornyl valerate.....		0.9533	20	-37.08	(295)
	<i>l</i> -Bornyl <i>dl</i> -ethoxypropionate.....	EtOH	0.9858	20	-33.2	(1347)
C ₁₆ H ₃₀ O ₂		EtOH	4.93	20	-30.7	
	<i>l</i> -Bornyl hexoate.....		0.9343	20	-31.45	(295)
C ₁₇ H ₂₂ O ₂	Bornyl benzoate.....	EtOH	25.8	15.5	43.92	(783)
C ₁₇ H ₂₃ NO ₂	<i>d</i> -Bornylphenylcarbamate (C ₁₀ H ₁₇ O.CO.NH.C ₆ H ₅).....	PhMe	5.46	15.5	34.22	(784)
C ₁₇ H ₂₄ O ₃ S	Bornyl toluene- <i>p</i> -sulfonate (C ₁₀ H ₁₇ O.SO ₂ .C ₆ H ₄ .CH ₃).....	EtOH	2.207	20	15.46	(451)
		C ₆ H ₆	2	20	15.46	
C ₁₈ H ₂₂ O ₄	<i>d</i> -Isobornyl hydrogen phthalate.....	CHCl ₃	5.18		76.88	(1629)
C ₁₈ H ₂₂ O ₄	<i>d</i> -Bornyl hydrogen phthalate.....	EtOH	30.2	15.5	58.38	(782)
		EtOH	5.07		56.7	(1629)
C ₁₈ H ₂₄ O ₃	<i>l</i> -Bornyl <i>d</i> -mandelate.....	EtOH	4.44	19	23.2	(1348)
	<i>l</i> -Bornyl <i>l</i> -mandelate.....	EtOH	4.64	20.5	-84.2	
C ₁₈ H ₂₄ O ₃	<i>l</i> -Bornyl <i>dl</i> -mandelate.....	EtOH	6.688	20	-30.4	(1347)
	Bornyl phenylpropionate.....	CHCl ₃	10	21	31.05	(900)
C ₁₉ H ₂₂ O ₂		CHCl ₃	2.5	22	31.40	
		Me ₂ CO	10	20	31.70	
		Me ₂ CO	2.5	22	30.20	
	Bornyl cinnamate.....	CHCl ₃	10	21	29.05	(900)
		CHCl ₃	2.5	21	28.40	
		Me ₂ CO	10	20	29.10	
C ₁₉ H ₂₄ O ₂		Me ₂ CO	2.5	22	27.60	
		EtOH	7.1		35.5	(1440)
	Bornyl β-phenylpropionate.....	CHCl ₃	10	20	30.25	(900)
		CHCl ₃	2.5	20	29.20	
C ₁₉ H ₂₆ O ₂		Me ₂ CO	10	20	29.00	
		Me ₂ CO	2.5	22	29.20	
C ₂₀ H ₂₈ O ₃	<i>l</i> -Bornyl <i>dl</i> -phenylethoxyacetate.....		1.0407	20	-27.5	(1347)
C ₂₀ H ₃₄ Cl ₂ O ₂ Si		EtOH	4.239	20	-29.1	
	Di- <i>l</i> -bornyl dichlorosilicate (SiCl ₂ (OC ₁₀ H ₁₇) ₂).....		1.0926	25.4	-30.3	(1597)
C ₂₄ H ₃₆ O ₄	Di- <i>l</i> -bornyl fumarate.....	EtOH	1.57		-45.2	(1434)
		CHCl ₃	5.28	10.5	-62	(1353)
C ₂₄ H ₃₈ O ₄		EtOH	1.54	9.5	-57.6	
	Dibornyl succinate.....	EtOH	1.57		-38.9	(1434)
C ₂₄ H ₃₈ O ₄		EtOH	39	15.5	42.05	(782)
	Di- <i>l</i> -bornyl <i>dl</i> -tartrate.....	CHCl ₃	3.96	10.5	-38.5	(1353)
C ₂₈ H ₃₈ O ₄	Dibornyl phthalate.....	EtOH	43.8	15.5	79.54	(782)
C ₂₈ H ₄₃ NO ₄	<i>l</i> -Menthylamine <i>d</i> -bornyl phthalate.....	EtOH	5.0		17.2	(1629)
C ₂₈ H ₅₀ O ₂	Bornyl oleate.....	EtOH	10.45		20.3	(1440)
C ₂₉ H ₅₂ O ₂	Bornyl stearate.....	C ₆ H ₆	10.5		19.9	(1440)
C ₃₀ H ₅₁ ClO ₃ Si	Tri- <i>l</i> -bornyl chlorosilicate (SiCl(OC ₁₀ H ₁₇) ₃).....	PhMe	16.5	20	-36.7	(1597)
C ₃₇ H ₅₆ N ₂ O ₄ S	<i>d</i> -Bornyl- <i>l</i> -bornyl benzamidine <i>d</i> -camphor-sulfonate.....	EtOH	4.1412	16	16.2	(340)

Borneol esters and carboxylates.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₄₀ H ₆₈ O ₄ Si	Tetra- <i>l</i> -bornyl silicate (Si(OC ₁₀ H ₁₇) ₄).....	PhMe	16.8	20	−42.88	(1597)
GLYCOLS						
C ₁₂ H ₂₂ O ₂	Campholethanol*.....	EtOH	5.0	15	19.95	(1553)
C ₂₀ H ₃₄ O ₂	Camphorpinacol (also derivatives).....	C ₆ H ₆	25.47	18	44.17	(102)
C ₂₀ H ₃₄ O ₂	<i>d</i> -Fenchonepinacol.....	AcOEt	16.8	15	45.00	(2122)
		C ₆ H ₆	17.24	18	32.08	
C ₂₅ H ₃₂ N ₂ O ₄	Phenylurethane homocamphoric glycol†.....	EtOH	5.7	21	31.48	(1553)
CARBOXYLIC ACIDS						
C ₁₁ H ₁₈ O ₃	α -Borneolcarboxylic acid.....	MeOH	12.44	22	−34.8	(2131)
C ₁₄ H ₂₂ O ₅	1-Methyl acid campholethanoyl-1-methanoate‡.....	EtOH	2.7	20	49.37	(1553)
AMINES						
MONOAMINES						
<i>Fenchylamine, thujylamine and derivatives</i>						
C ₁₀ H ₁₇ NO	Fenchylecarbimide.....		0.9210	19	3.04	(2122)
C ₁₀ H ₁₉ N	<i>l</i> -Fenchylamine; cf. (145, 2110, 2126).....	EtOH	2.63	19	−24.63	(2108)
C ₁₁ H ₁₉ NOS	<i>l</i> -Fenchylxanthamide (C ₁₀ H ₁₇ O.CS.NH ₂)....	C ₆ H ₆	10.40		−78.51	(299)
C ₁₀ H ₂₀ ClN	Fenchylamine hydrochloride.....	H ₂ O	18.52	20	2.95	(2122)
C ₁₂ H ₂₃ N	Dimethylthujylamine.....		0.8606 ²⁰ ₄		141.76	(297)
C ₁₃ H ₂₅ INO	Trimethylthujylammonium iodide.....	CHCl ₃	3.979		42.61	(297)
<i>Bornylamine with alkyl and alkylidene derivatives</i>						
C ₁₀ H ₁₉ N	Bornylamine.....	C ₆ H ₆			57.1	(575, 576)
		EtOH			46.2	
C ₁₀ H ₂₀ IN	Bornylamine hydroiodide.....	EtOH?			16.0	
C ₁₁ H ₂₁ N	Methylbornylamine.....				96.8	
		C ₆ H ₆	2.069	19	95.9	
		EtOH	2.026	23	81.0	
C ₁₁ H ₂₂ ClN	Methylbornylamine hydrochloride.....	EtOH	2.4		31.0	
C ₁₁ H ₂₂ IN	Methylbornylamine hydroiodide.....	EtOH	1.0		26.6	
C ₁₂ H ₂₃ N	Dimethylbornylamine.....			16	62.5	
		C ₆ H ₆	1.558	10	59.6	
		EtOH	2.606	10	48.7	
C ₁₂ H ₂₃ N	Ethylbornylamine.....			21	93.0	
		C ₆ H ₆	2.031	15	90.3	
		EtOH	2.673	15	75.4	
C ₁₂ H ₂₄ ClN	Dimethylbornylamine hydrochloride.....	EtOH			37.2	
C ₁₂ H ₂₄ ClN	Ethylbornylamine hydrochloride.....	H ₂ O	1.3		35.6	
C ₁₂ H ₂₄ IN	Ethylbornylamine hydroiodide.....	EtOH	2.0		26.6	
C ₁₃ H ₂₅ N	Propylbornylamine.....			18	89.0	
		C ₆ H ₆	2.420	15	87.1	
		EtOH	2.084	16	72.0	
C ₁₃ H ₂₅ N	Isopropylbornylamine.....			14	84.0	
		C ₆ H ₆	2.003	16	81.1	
		EtOH	2.014	16	63.3	
C ₁₃ H ₂₆ ClN	Propylbornylamine hydrochloride.....	EtOH	2.0		34.4	
C ₁₃ H ₂₆ IN	Propylbornylamine hydroiodide.....	EtOH	1.7		25.0	
C ₁₃ H ₂₆ IN	Trimethylbornylammonium iodide.....	EtOH	2.9		−3.9	
C ₁₄ H ₂₇ N	Diethylbornylamine.....	C ₆ H ₆	1.596	15	62.6	
		EtOH	1.981	22	50.5	
C ₁₄ H ₂₇ N	Butylbornylamine.....			15	81.7	
		C ₆ H ₆	1.947	16	80.3	
		EtOH	1.993	16	64.8	
C ₁₄ H ₂₈ ClN	Butylbornylamine hydrochloride.....	EtOH	2.0		32.7	
C ₁₄ H ₂₈ IN	Butylbornylamine hydroiodide.....	EtOH	2.0		23.8	
C ₁₄ H ₂₈ IN	Dimethylethylbornylammonium iodide.....	EtOH	2.0	18	−3.3	
C ₁₆ H ₃₀ IN	Dimethylpropylbornylammonium iodide....	EtOH	2.03	16	−4.1	
C ₁₆ H ₃₂ IN	Dimethylbutylbornylammonium iodide.....	EtOH	2.0		−3.1	
C ₁₇ H ₂₂ N ₂ O ₂	<i>o</i> -Nitrobenzylidenebornylamine.....	C ₆ H ₆	2.004	23	41.6	
		EtOH	2.032	23	8.6	
	<i>p</i> -Nitrobenzylidenebornylamine.....	C ₆ H ₆	1.628	15	23.0	
		EtOH	1.795		51.5	



Bornylamine with alkyl and alkylidene derivatives.—(Continued)

Formula	Name	Solvent	d, C or $\%$	$t, ^\circ C$	$[\alpha]_D$	Lit.
$C_{17}H_{23}NO$	Benzoylbornylamine.....	EtOH			-21.8	(635)
$C_{17}H_{23}N$	Benzylidenebornylamine.....	C_6H_6	2.005	20	27.4	(575, 576)
		EtOH	2.051	19	62.6	
$C_{17}H_{23}NO$	<i>o</i> -Hydroxybenzylidenebornylamine.....	EtOH	1.951	23	112.3	
	<i>p</i> -Hydroxybenzylidenebornylamine.....	EtOH	2.022		107.1	
$C_{17}H_{24}N_2O_2$	<i>o</i> -Nitrobenzylbornylamine.....	C_6H_6	2.033	15	74.0	
		EtOH	2.027	15	61.2	
$C_{17}H_{24}N_2O_2$	<i>p</i> -Nitrobenzylbornylamine.....	C_6H_6	2.033	15	77.9	
		EtOH	2.015	22	66.6	
$C_{17}H_{25}ClN_2O_2$	<i>o</i> -Nitrobenzylbornylamine hydrochloride....		2.0		113.2	
$C_{17}H_{25}ClN_2O_2$	<i>p</i> -Nitrobenzylbornylamine hydrochloride....	EtOH	2.0		20.3	
$C_{17}H_{25}N$	Benzylbornylamine.....			17	82.2	
		C_6H_6	2.010	14	84.1	
		EtOH	2.228	20	75.7	
$C_{17}H_{26}ClN$	Benzylbornylamine hydrochloride.....	EtOH	1.7		35.8	
$C_{18}H_{25}NO$	Benzoylmethylbornylamine.....	EtOH	1.772	24	-65.5	
$C_{19}H_{27}NO$	Benzylethylbornylamine.....	EtOH	2.761	21	-65.2	
$C_{20}H_{29}NO$	Benzylpropylbornylamine.....	EtOH	1.961	14	-60.3	
$C_{20}H_{34}BrNO_4S$	<i>d</i> -Bornylamine <i>d</i> - α -bromocamphor- π -sulfonate.....	EtOH	0.604		81.0	(1676)
		H_2O	0.616		67.3	
<i>Acyl derivatives of bornylamine</i>						
$C_{11}H_{19}NO$	Formobornylamide.....	EtOH	5.3	20	-43.17	(635)
		MeOH	5.0	20	-40.88	
		MeOH	10.0	20	41.01	
		AcOH	5.6	20	-13.80	
		AcOH	9.7	20	-15.30	
		Py	5.0	20	-16.96	
		Py	10.0	20	-18.60	
$C_{12}H_{21}NO$	Acetobornylamide.....	EtOH	4.9	20	-43.48	(635)
		MeOH	5.0	20	-41.93	
		MeOH	10.0	20	-42.10	
		AcOH	5.0	20	-34.80	
		AcOH	10.0	20	-36.14	
		Py	4.9	20	-11.97	
		Py	10.0	20	-15.14	
$C_{13}H_{23}NO$	Propionobornylamide.....	EtOH	5.0	20	-40.79	
		MeOH	5.0	20	-38.68	
		MeOH	10.0	20	-39.48	
		AcOH	5.0	20	-37.19	
		AcOH	10.0	20	-37.54	
		Py	5.0	20	-14.64	
		Py	10.0	20	-16.38	
$C_{14}H_{25}NO$	<i>n</i> -Butyrobornylamide.....	EtOH	5.0	20	-37.73	(635)
		EtOH			-21.8	(575, 576)
		MeOH	5.0	20	35.73	(635)
		MeOH	10.0	20	35.86	
		AcOH	5.0	20	34.89	
		AcOH	10.0	20	35.29	
		Py	4.9	20	-12.57	
		Py	10.0	20	-15.06	
$C_{17}H_{23}NO$	Benzobornylamide.....	EtOH	5.0	20	-22.93	(635)
		EtOH	10.0	20	-24.37	
		MeOH	5.0	20	22.35	
		MeOH	10.0	20	23.30	
		AcOH	5.0	20	10.17	
		AcOH	10.0	20	11.65	
		Py	5.0	20	25.94	
		Py	10.0	20	22.98	
$C_{17}H_{22}N_2O_3$	<i>o</i> -Nitrobenzobornylamide.....	EtOH	5.0		-22.39	(635)
		MeOH	5.1	20	30.32	
		AcOH	3.9	20	13.54	
		Py	5.0	20	-5.88	
		Py	10.0	20	-7.67	

Acyl derivatives of bornylamine.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.		
C ₁₇ H ₂₂ N ₂ O ₃	<i>m</i> -Nitrobenzobornylamide.....	EtOH	2.6	20	−27.9	(635)		
		MeOH	1.9	20	24.62			
		AcOH	3.9	20	12.16			
		Py	5.00	20	27.22			
		Py	9.99	20	22.16			
	<i>p</i> -Nitrobenzobornylamide.....	EtOH	4.28	20	−16.75	(635)		
		MeOH	5.00	20	−13.44			
		AcOH	3.83	20	−7.28			
		Py	4.7	20	26.41			
		Py	9.9	20	22.80			
C ₁₈ H ₂₆ NO	<i>o</i> -Toluobornylamide.....	EtOH	2.5	20	−18.54	(635)		
		MeOH	2.0	20	−17.02			
		MeOH	4.0	20	−17.01			
		AcOH	5.0	20	−10.38			
		AcOH	10.0	20	−11.34			
		Py	5.0	20	11.21			
		Py	10.0	20	10.24			
	<i>m</i> -Toluobornylamide.....	EtOH	2.5	20	−21.31	(635)		
		EtOH	5.0	20	−22.40			
		MeOH	2.0	20	−20.37			
		MeOH	4.0	20	−21.60			
		AcOH	5.0	20	−8.15			
		AcOH	10.0	20	−8.98			
		Py	5.0	20	26.90			
	<i>p</i> -Toluobornylamide.....	Py	10.0	20	23.05	(635)		
		EtOH	2.5	20	−13.37			
		EtOH	5.0	20	−14.55			
		MeOH	2.0	20	−12.18			
		MeOH	4.0	20	−12.51			
		AcOH	1.0	20	±0.0			
		AcOH	5.0	20	−0.49			
		AcOH	10.0	20	−1.51	(635)		
		Py	5.0	20	30.60			
		Py	7.8	20	29.03			
		Py	10.0	20	27.39			
C ₂₁ H ₃₇ NO ₂		<i>l</i> -Bornyl <i>l</i> -menthylcarbamate.....	EtOH	3.4			−71.04	(1629)
		<i>dl</i> -Isobornyl <i>l</i> -menthylcarbamate*.....	EtOH	5			−55.8	
		<i>d</i> -Isobornyl <i>l</i> -menthylcarbamate.....	EtOH	2.67			1.41	
		<i>l</i> -Isobornyl <i>l</i> -menthylcarbamate.....	EtOH	2.64			−112.0	
<i>Bornylcarbimide, carbamide and other derivatives of dibasic acids</i>								
C ₁₁ H ₁₇ NO	Bornylcarbimide (C ₁₀ H ₁₇ .N:CO).....	CHCl ₃	3.76		46.5	(590)		
		C ₆ H ₆	4.5		49.14	(1514); cf. (590)		
C ₁₁ H ₂₀ N ₂ O	Bornylcarbamide (C ₁₀ H ₁₇ .NH.CO.NH ₂).....	CHCl ₃	2.15		18.2	(590)		
C ₁₂ H ₂₀ N ₂ O ₂	Bornyloxamide (C ₁₀ H ₁₇ .NH.CO.CO.NH ₂)...	EtOH	2		−24.1	(598)		
C ₁₃ H ₂₃ NO ₂	Ethyl bornylcarbamate (C ₁₀ H ₁₇ .NH.CO.OC ₂ H ₅).....	CHCl ₃	2.25		6.43	(1514)		
		C ₆ H ₆	2.19		4.79			
		C ₆ H ₆	2.04		−9.63			
C ₁₆ H ₂₈ N ₂ O	<i>s</i> -Bornylpiperidylcarbamide (C ₁₀ H ₁₇ .NH.CO.N.C ₆ H ₁₀).....	EtOH	1.35		40.0	(590)		
C ₂₁ H ₃₄ N ₂ O ₂	<i>s</i> -Camphorylborylcarbamide (C ₁₀ H ₁₆ O.NH.CO.NH.C ₁₀ H ₁₇).....	CHCl ₃	1.2		28.6	(591)		
C ₂₁ H ₃₆ N ₂ O	Dibornylcarbamide (CO.(NH.C ₁₀ H ₁₇) ₂).....	CHCl ₃	1.09		32.12	(1514)		
C ₂₂ H ₃₆ N ₂ O ₂	Dibornyloxamide ((CO.NH.C ₁₀ H ₁₇) ₂).....	EtOH	2.0		−29.6	(598)		
C ₃₉ H ₆₀ NO ₄ S	Ethyl- <i>d</i> -bornyl- <i>l</i> -bornylbenzamidine <i>d</i> -camphorsulfonate.....	EtOH	3.995	16	16.1	(1597)		

CLASS III. COMPOUNDS CONTAINING NO ASYMMETRIC CARBON ATOM OR CONTAINING AN ASYMMETRIC OR DISSYMMETRIC ATOM OF SOME OTHER ELEMENT†

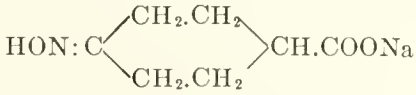
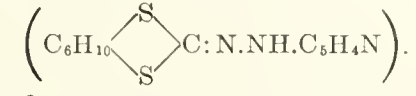
Centro-Asymmetric Carbon Compounds

Cyclohexylideneacetic acid

C ₁₂ H ₄₀ N ₂ O ₆	Brucine <i>l</i> -1-methylcyclohexylidene-4-acetate	EtOH	0.7607		−58.2	(1601.5)
		EtOH (abs.)	0.775		−58.1	(1601)

* C₁₀H₁₇O.CO.NH.C₁₀H₁₉.† For C₉H₁₃CoN₆O₃, Cobalt tri-*l*-propylenediamine hydroxide iodide, see p. 365.

Cyclohexylideneacetic acid.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _{<i>D</i>}	Lit.
C ₃₂ H ₄₀ N ₂ O ₆	Brucine <i>l</i> -1-methylcyclohexylidene-4-acetate. (Continued)	EtOH (abs.)	1.986		−49.8	
		EtOH (abs.)	2.833		−46.9	
		MeOH	0.839		−78.6	
		H ₂ O	0.727		−38.6	
	Brucine <i>d</i> -1-methylcyclohexylidene-4-acetate	EtOH	0.7431		11.5	(1601.5)
		EtOH (abs.)	1.171		−11.5	(1601)
		EtOH (abs.)	2.002		−3.9	
		EtOH (abs.)	2.767		−1.4	
		EtOH (abs.)	5.189		2.4	
		MeOH	0.700		−22.1	
		H ₂ O	0.700		−2.9	
Nitrogen derivatives (oximes, etc.)						
C ₇ H ₁₀ NO ₃ Na	Sodium <i>d</i> -oximinoecyclohexane-4-carboxylate	H ₂ O	2.98		41.6	(1424)
						
C ₁₂ H ₁₆ N ₃ S ₂	<i>d</i> -Cyclohexylene dithiocarbonate- 2-pyridylhydrazone 	CS ₂	1.032	17	46.3	(1427)
		EtOH	0.308	17	46	
		EtOH	0.338	18	−83	
C ₉ H ₁₃ NO	<i>d</i> -Methylethylaniline oxide (C ₆ H ₅ .N.CH ₃ .C ₂ H ₅ O).....	H ₂ O	1.5		+16.1	(1411.5)
		C ₆ H ₆	1.8		+6.1	
Derivatives of diphenic acid						
C ₁₄ H ₆ N ₃ O ₁₀ Na	Sodium <i>d</i> -4, 6, 4'-trinitrodiphenate.....	H ₂ O	1.5	16	156.8	(293)
C ₁₄ H ₆ O ₄ Cl ₂ Na ₂	Sodium <i>l</i> -6, 6'-dichlorodiphenate.....	H ₂ O	0.69	15	−20.18	(292)
	Sodium <i>d</i> -6, 6'-dichlorodiphenate.....	H ₂ O	1.01	15	21.43	
Optically Active Quinquevalent Nitrogen Compounds (730, 1969)						
C ₁₃ H ₁₅ NO.3H ₂ O	<i>d</i> -Methylethyl-β-naphthylamine oxide (C ₁₀ H ₇ .N(CH ₃)(C ₂ H ₅)O).....	H ₂ O	2.02		+14.8	(1411.5)
					−15.4	
C ₁₄ H ₂₁ BrIN	<i>p</i> -Bromophenylmethyl- <i>n</i> -butylallyl- ammonium iodide.....	EtOH	1.13		27.97	(437)
		CHCl ₃	4.78		44.36	
C ₁₄ H ₂₂ IN	<i>d</i> -Phenylmethyl- <i>n</i> -butylallylammonium iodide (C ₆ H ₅ .N(CH ₃)(C ₄ H ₉)(C ₃ H ₅)I).....	EtOH	1.28	15	31.78*	(437)
		CHCl ₃	0.70	15	34.17*	
C ₁₄ H ₂₂ IN	Phenylmethylallylisobutylammonium iodide	EtOH	0.77	17	−19.08	(2013)
		CHCl ₃	0.574	17	0*	
C ₁₅ H ₂₃ BrIN	<i>d</i> -Bromophenylmethylisoamylallyl- ammonium iodide.....	EtOH			26.2	(1009)
		CHCl ₃	0.73		39.9	
C ₁₅ H ₂₄ BrN	<i>l</i> -1-Benzyl-1-ethyl-2-pipecolinium bromide (CH ₃ .C ₅ H ₉ N(C ₂ H ₅)(CH ₂ .C ₆ H ₅)Br).....	EtOH	10		20	(1887)
C ₁₅ H ₂₄ IN	<i>l</i> -1-Benzyl-1-ethyl-2-pipecolinium iodide.....	EtOH	10		−52.5	(1887)
C ₁₅ H ₂₄ IN	<i>d</i> -α-Phenylmethylallyl- <i>l</i> -amylammonium iodide	EtOH	3.436		14.3	(1007)
		CHCl ₃	3.444		21.78*	(1007)
					3.1	(1007)
C ₁₆ H ₂₀ IN	<i>d</i> -Phenylbenzylmethylethylammonium iodide.....	EtOH	2.25		7.8	(1005)
		EtOH	2.22		−8.5	(1006)
C ₁₇ H ₁₉ BrIN	<i>p</i> -Bromophenylbenzylmethylallylammonium iodide.....	EtOH	0.97	14	−55	(437)
		CHCl ₃	0.85	15	−72*	
C ₁₇ H ₂₀ BrN	<i>d</i> -Benzylphenylallylmethylammonium bromide.....	CHCl ₃	0.495	16.5	64.1	(1668)
		EtOH	0.97		68.6	(1673)
	<i>l</i> -Benzylphenylallylmethylammonium bromide.....	EtOH	1.49		67.3	

* Mutarotation.

Optically Active Quinquevalent Nitrogen Compounds.—(Continued)

Formula	Name	Solvent	d , C or %	t , °C	$[\alpha]_D$	Lit.
$C_{17}H_{20}IN$	<i>d</i> -Benzylphenylallylmethylammonium iodide	$CHCl_3$	1.05	17	55.4	(1668)
		$CHCl_3$	1.11	14	56.7	(835)
		50% Me_2CO + MeOH	0.97		52.5	(1673)
	<i>l</i> -Benzylphenylallylmethylammonium iodide	50% Me_2CO + 50% MeOH	2.07		−51.4	
$C_{17}H_{21}NO$	α -Phenylbenzylmethylallylammonium hydroxide.....	EtOH aq.	0.794	18	75.5	(2138)
$C_{17}H_{22}ClIN$	<i>l</i> -Phenylbenzylmethylpropylammonium chloride.....	$CHCl_3$	0.46		−143.8	(2154)
$C_{17}H_{22}IN$	<i>l</i> -Phenylbenzylmethylpropylammonium iodide.....	EtOH	0.466		−96.47	(2146)
		$CHCl_3$	0.515		−102	
		EtOH	0.71	17	−116.2	(2013)
		$CHCl_3$	0.52		−139	
$C_{17}H_{22}N_2O_3$	<i>d</i> -Phenylbenzylmethylpropylammonium nitrate.....	$CHCl_3$	2.8		14	(2139)
$C_{17}H_{28}IN$	α -Benzylethylconium iodide ($C_3H_7.C_6H_9N(C_2H_5)(CH_2C_6H_5)I$).....	MeOH	8	20	21.2	(1884)
		MeOH	8	20	31.2	
$C_{18}H_{22}IN$	<i>p</i> -Tolylbenzylmethylallylammonium iodide..	EtOH	0.4		−66.7	(438)
		$CHCl_3$	0.34		−66.9	
$C_{18}H_{22}INO$	<i>p</i> -Methoxyphenylbenzylmethylallyl- ammonium iodide.....	$CHCl_3$	4	20	6.39	(693)
$C_{18}H_{23}BrIN$	<i>l-p</i> -Bromophenylbenzylmethyl- <i>n</i> -butyl- ammonium iodide.....	EtOH	0.94	15	−77.13	(437)
		$CHCl_3$	0.64		7.100*	
$C_{18}H_{24}IN$	<i>l</i> -Phenylbenzylmethylbutylammonium iodide	EtOH	0.72	20	−83.66	(694)
		$CHCl_3$	0.77	20	−90.61	
$C_{18}H_{24}IN$	<i>l</i> -Phenylbenzylmethylisobutylammonium iodide.....	EtOH	0.52		−99.2	(2147); cf.
		$CHCl_3$	0.36		−98.5*	(2013)
$C_{19}H_{24}INO$	<i>l-p</i> -Ethoxyphenylbenzylmethylallyl- ammonium iodide.....	$CHCl_3$	5.23	20	−1.63	(2147.5)
$C_{19}H_{26}IN$	α -Phenylbenzylmethyl- <i>l</i> -amylammonium iodide.....	EtOH	1.21		59	(1007)
		$CHCl_3$	0.864		65*	(1007)
		EtOH	1.831		−15.8	
		$CHCl_3$	1.22		−18.8*	
$C_{19}H_{26}IN$	<i>l</i> -Phenylbenzylmethylisoamylammonium iodide.....	EtOH	1.33		−87	(201.3)
		$CHCl_3$	0.72		−100*	
$C_{20}H_{34}IN$	α -Benzylisoamylconium iodide.....	$CHCl_3$	7.5	20	26.6	(1884)
		$CHCl_3$	7.5	20	33.3	
$C_{23}H_{32}BrNO_4S$	<i>l</i> -Allylkairolinium <i>d</i> -bromocamphor- sulfonate†.....	H_2O	0.94		39.1	(258)
		H_2O	0.9608		68.6	
$C_{24}H_{38}INO_2$	<i>N</i> -Isopropyltetrahydroisoquinolinium- <i>l</i> - menthyl acetate iodide‡ (<i>a</i>) stable form....	EtOH	0.698	20	−40.12	(2151)
		EtOH	0.478	20	−12.54	
$C_{24}H_{38}INO_2$	<i>N-n</i> -Propyltetrahydroisoquinolinium- <i>l</i> - menthyl acetate iodide.....	EtOH	1.02		−22.6	(2150)
		$CHCl_3$	1.16		−23.2	
		$CHCl_3$	0.79		−31.7	
		EtOH	0.99		−31.86	
$C_{26}H_{36}I_2N_2$	<i>p</i> -Methylene-bisphenylencbis-(methyl- ethylallylammonium iodide) ($CH_2(C_6H_4.NI(CH_3)(C_2H_5)(C_3H_5)_2)$).....	60% EtOH	0.99	20	−11.11	(692)

* Mutarotation.

† $CH_2.CH_2.CH_2$ $C_6H_4-N(CH_3)(C_6H_5)SO_3.C_{10}H_{14}BrO$.‡ $C_6H_4 \begin{array}{c} \diagup CH_2.CH_2 \\ \diagdown CH_2 \end{array} NI(C_3H_7)CH_2.CO.O.C_{10}H_{19}$.

Optically Active Quinquevalent Nitrogen Compounds.—(Continued)

Formula	Name	Solvent	d, C or $\%$	$t, ^\circ C$	$[\alpha]_D$	Lit.
$C_{25}H_{40}INO_2$	<i>N</i> -Butyltetrahydroisoquinolinium <i>l</i> -menthyl acetate iodide (a) stable form.....	EtOH	1.0	20	-29.2	(2151)
	(b) unstable form.....	EtOH	1.0	20	-18.1	
$C_{25}H_{42}INO_2$	<i>N</i> -Isoamyltetrahydroisoquinolinium <i>l</i> -menthyl acetate iodide (a) stable form....	EtOH	1.0	20	6.4	(2151)
	(b) unstable form..	EtOH	1.0	20	-26.1	
$C_{25}H_{38}BrNO_5S$	<i>l-p</i> -Ethoxyphenylbenzylmethylallyl-ammonium <i>d</i> -bromocamphorsulfonate.....	H ₂ O	2.27	20	7.95	(2147.5)
$C_{32}H_{49}IN_2O_2$	Ethylene-di- <i>d</i> -benzylconiinium iodide (α-salt).....	MeOH	1.008		40.42	(1673); cf.
	(β-salt).....	MeOH	0.420		15.42	(1884)

Substances Probably, or Certainly, Containing Optically Active Phosphorus Atoms

$C_9H_{13}OP$	α-Methylethylphenylphosphine oxide (C ₆ H ₅).P.(CH ₃)(C ₂ H ₅)O.....	H ₂ O	1.34		39	(1412)
		C ₆ H ₆	0.887		57	
$C_{23}H_{32}NO_3P$	Phenyl- <i>p</i> -tolylphosphoric <i>l</i> -menthylamide* (α-isomeride).....	98% MeOH	1.3		-32.3	(1311.5)
	(β-isomeride).....	98% MeOH	1.107		-37.9	
$C_{25}H_{32}NO_3P$	α-Phenyl β-naphthyl phosphoric <i>l</i> -menthylamide†.....	MeOH	2.336		-37.2	(1074)
	β-Phenyl β-naphthyl phosphoric <i>l</i> -menthylamide.....	MeOH	1.521		-29.1	
$C_{25}H_{34}NO_4P$	<i>l</i> -Menthylamine phenyl β-naphthyl phosphate‡.....	MeOH	1.4980		-15.5	(1074)
$C_{35}H_{37}N_2O_5P$	Quinine phenyl β-naphthyl phosphate.....	MeOH	0.6492		-108.6	(1074)
		MeOH	0.7612		-108.4	

Compounds Containing Optically Active Sulfur or Selenium

$C_{18}H_{22}Cl_6O_4PtSe_2$	<i>d</i> -Phenylmethylselenetene chloroplatinate§...	Me ₂ CO	2.15		6.34	(1669)
$C_{10}H_{22}Cl_6O_4PtS_2$	<i>d</i> -Methylethylthetine chloroplatinate.....	H ₂ O	1.33		4.6	(1674)
$C_{17}H_{17}N_3O_8S$	<i>l</i> -Methylethylphenacylsulfine picrate.....	Me ₂ CO	2.07		-9.2	(1967)
	<i>d</i> -Methylethylphenacylsulfine picrate.....	Me ₂ CO	1.96		8.1	
$C_{22}H_{30}Cl_6O_2PtS_2$	<i>l</i> -Methylethylphenacylthetine chloroplatinate	HCl (concd.)	0.42		-7.7	(1669)

Compounds Containing Optically Active Silicon

$C_{23}H_{35}O_7S_2Si_2Na_2$	<i>d</i> -Sulfobenzylethylpropylsilicyl oxide, sodium salt.....	H ₂ O	6.85		5.2	(1072)
$C_{24}H_{38}O_7S_2Si_2Na_2$	<i>d</i> -Sulfobenzylethylisobutylsilicyl oxide, sodium salt 	H ₂ O	3.32		10.4	(1311)

Salts of dibenzylpropylethylsilicanemonosulfonic acid, C₆H₅.CH₂.Si.C₂H₅.C₃H₇.CH₂.C₆H₅.SO₂.OH

$C_{19}H_{25}O_3SSiNa$	Sodium <i>l</i> -salt.....	MeOH			-0.87	(282)
$C_{29}H_{47}NO_3SSi$	<i>l</i> -Menthylamine <i>dl</i> -salt.....	MeOH	2.8		-13.4	
$C_{29}H_{47}NO_3SSi$	<i>l</i> -Menthylamine <i>l</i> -salt.....	MeOH	13.6		-13.8	
$C_{35}H_{45}NO_6SSi$	Morphine <i>dl</i> -salt.....	MeOH	1.68		-52.2	
$C_{35}H_{45}NO_6SSi$	Morphine <i>l</i> -salt.....	MeOH	1.66		-56.0	
$C_{38}H_{48}N_2O_4SSi$	Cinchonidine <i>dl</i> -salt.....	MeOH	2.23		-62.1	
$C_{38}H_{48}N_2O_4SSi$	Cinchonidine <i>l</i> -salt.....	MeOH	2.1		-66.3	
$C_{39}H_{50}N_2O_6SSi$	Quinine <i>dl</i> -salt.....	MeOH	1.612		-111.3	
$C_{39}H_{50}N_2O_6SSi$	Quinine <i>l</i> -salt.....	MeOH	2.13		-109.5	
$C_{40}H_{48}N_2O_5SSi$	Strychnine <i>dl</i> -salt.....	MeOH	3.0		-8.3	
$C_{40}H_{48}N_2O_5SSi$	Strychnine <i>l</i> -salt.....	MeOH	3.5		-11.1	

CLASS IV. SUBSTANCES OF UNKNOWN, DOUBTFUL OR COMPLEX STRUCTURE

Hydrocarbons and Their Simple Derivatives

$C_{15}H_{24}$ or $C_{15}H_{22}$	Calamene.....		0.9324 ²³ ₂₃	26	-1.131	(2016)
			0.9324 ²⁰ ₁₉	20	6	(1939)
			0.9224 ²⁰ ₁₉	20	5	(1939)
$C_{15}H_{24}$	Cadinene.....		0.9224 ¹⁵	20	48.11	(748)
		CHCl ₃	13.05	9.5	-98.56	
$C_{15}H_{24}$	Cedrene (from pseudocedrol).....		0.9338	20	-60	(1929)
$C_{15}H_{24}$	Cyclosesquictronellene.....		0.8892 ²⁰		63	(1940)
$C_{15}H_{24}$	Cypressene.....		0.9647 ¹⁸	20	6.53	(1531)
$C_{15}H_{24}$	Eudesmene.....		0.9232	20	51	(1942)
			0.9964	20	54.10	(1935)

* $\begin{matrix} C_6H_5O \\ CH_3.C_6H_4.O \end{matrix} \rangle PO.NH.C_{10}H_{19}$. † $\begin{matrix} C_6H_5.O \\ C_{10}H_7.O \end{matrix} \rangle PO.NH.C_{10}H_{19}$. ‡ $\begin{matrix} C_6H_5.O \\ C_{10}H_7.O \end{matrix} \rangle PO.ONH_3 + C_{10}H_{19}$. § (C₆H₅.Se(CH₃).CH₂.COOH)₂PtCl₄.
 || O(Si(C₂H₅)(C₃H₇).CH₂.C₆H₄.SO₂.OH)₂, sodium salt.

Hydrocarbons and Their Simple Derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₁₅ H ₂₄	Guajene.....		0.8954	25	−66.11	(708)
C ₁₅ H ₂₄	β-Gurjunene.....		0.9329	20	20.4	(1941)
C ₁₅ H ₂₄	α-Santalene.....		0.9132 ¹⁵		−3.07	(1872)
	β-Santalene.....		0.894 ²⁰		−41.0	
C ₁₅ H ₂₄	Sesquicamphene.....		0.9015	20	3	(1937)
C ₁₅ H ₂₄	Sesquictronellene.....		0.8489 ²⁰		0.71	
C ₁₅ H ₂₄ N ₂ O ₄	Caryophyllene nitrosate.....	C ₆ H ₆	2.09	18	56.91	(384)
C ₁₅ H ₂₆	Dihydroeudesmene.....		0.9067	20	−7	(1942)
C ₁₅ H ₂₆	Dihydroguajene.....		0.9089 ⁰	18.5	−26.65	(708)
C ₁₅ H ₂₆	Dihydro-β-gurjunene.....		0.9239	20	−40.1	(1941)
C ₁₅ H ₂₆	Dihydrosesquictronellene.....		0.8316		0	(1940)
		CHCl ₃		20	8.91	(748)
		AcOEt		20	25.67	
C ₁₅ H ₂₈	Tetrahydrocalamene.....		0.8951 ²⁰	20	0	(1939)
C ₁₅ H ₂₈	Tetrahydrocaryophyllene.....		0.8712	20	3	(1930)
C ₁₅ H ₂₈	Tetrahydroeudesmene.....		0.8893	20	10.20	(1935)
C ₁₅ H ₂₈	Tetrahydroguajene.....		0.8806	20	10.60	(1935)
C ₁₅ H ₂₈	Tetrahydrosantalene.....		0.8655	20	5.60	(1935)
C ₁₅ H ₂₈	Hydrocarbon from reduction of santalol....		0.8550	20	2.80	(1935)
C ₁₅ H ₃₂	Octahydrosesquictronellene.....		0.7789 ²⁰		0	(1940)
C ₂₇ H ₄₆	Cholestene.....	CHCl ₃	3.50		−56.27	(1402)
C ₂₇ H ₄₆	ψ-Cholestene.....	CHCl ₃ ?	3.18	23	64.86	(1403)
C ₂₇ H ₄₆	Necholestene.....	EtOH?	3.02	20	64.07	(1404)
C ₂₇ H ₄₆ Br ₂	α-Cholestene dibromide.....	CHCl ₃	3.05		48.9	(1402)
	β-Cholestene dibromide.....	CHCl ₃	3.02		39.4	
C ₂₇ H ₄₆ Br ₂	ψ-Cholestene dibromide.....	CHCl ₃	3.19	20	83.4*	(1403)
		C ₆ H ₆	3.21		46.9*	
C ₂₇ H ₄₆ Br ₂	Necholestene dibromide.....	EtOH?	3.10	23	75.27	(1404)
C ₂₇ H ₄₆ Cl ₂	Cholestene dichloride.....	CHCl ₃	3.20		−28.7	(1402)
C ₂₇ H ₄₇ Cl	Chlorocholestane.....	CHCl ₃	3.138	20	29.49	(1404)
		C ₆ H ₆	3.035	22	24.22	
C ₂₇ H ₄₇ Cl	Cholestene hydrochloride.....	CHCl ₃	3.21		21.8	(1402)
C ₂₇ H ₄₈	Cholestane.....	CHCl ₃	3.03	21	24.42	(1404)
	ψ-Cholestane.....	CHCl ₃	3.025	22	25.45	
C ₃₀ H ₄₈	d-α-Amyrilene.....	C ₆ H ₆	4		109.48	(2067)
	l-α-Amyrilene.....	C ₆ H ₆	0.871		104.9	
	l-β-Amyrilene.....	C ₆ H ₆	1.5		112.2	
Alcohols, Esters and Ethers						
C ₁₀ H ₁₈ O ₃	Ascaridolglycol.....		1.0981 ²⁰		0	(1492)
C ₁₁ H ₁₆ O	Nortricycloeksantalol.....		0.9938 ²⁰		−38.80	(1872)
C ₁₁ H ₁₈ O	d-Tricycloeksantalol.....		0.989 ¹³		7.7	(1921)
C ₁₅ H ₁₄ O ₆	l-Catechin (λ = 5790).....	50% Me ₂ CO	3.49		16.7	(670)
		EtOH			0	
	l-Epicatechin.....	EtOH	2.39		−68	
		50% Me ₂ CO	4.35		−60	
C ₁₅ H ₂₄ O	Cedrenol.....		1.0083	20	0	(1930)
C ₁₅ H ₂₄ O	Vetivenol (tricyclic).....		1.0208	20	34.33	(1936)
	(bicyclic).....		1.0095	20	25	
C ₁₅ H ₂₄ O	α-Santalol.....		0.9788 ¹⁵		1.21	(1872)
C ₁₅ H ₂₆ O	Eudesmol.....		0.9884	20	31.25	(1942)
C ₁₅ H ₂₆ O	Guajol.....	95% EtOH		25	−26.64	(708)
C ₁₅ H ₂₆ O	Pseudocedrol.....		0.9964	20	21.5	(1930)
C ₁₅ H ₂₆ O	Globulol.....	CHCl ₃	12	20	−35.48	(1942)
C ₁₅ H ₂₆ O ₂	Calameon.....	EtOH	5.04	26	−8.94	(2016)
C ₁₇ H ₂₄ O ₁₀	Verbenalin.....	H ₂ O	2.04		−180.5	(178)
C ₁₇ H ₂₆ O ₂	Vetivenyl (tricyclic) acetate.....		1.0218	20	28.8	(1936)
C ₁₇ H ₂₈ O ₂	Eudesmyl acetate.....		0.9933	20	31	(1942)
C ₁₇ H ₃₀ O ₂	Dihydroeudesmyl acetate.....		0.9776	20	13	(1942)
C ₁₉ H ₂₀ O ₆	Matairesinol.....	Me ₂ CO	5.0	15	−4.89	(405)
C ₁₉ H ₂₂ O ₆	Tetramethyl-l-catechin.....	C ₂ H ₂ Cl ₄	2.27		12	(670)
	Tetramethyl-l-epicatechin (λ = 5790).....	C ₂ H ₂ Cl ₄	2.12		−61.5	
C ₂₀ H ₂₄ O	Isoolivile.....	H ₂ O	0.397	12	352	(1120.5)
		AcOH	4.024	12	118	(1120.5)
		EtOH	4.036	25	61.1	(1120.5)

* Mutarotation.

Alcohols, Esters and Ethers.—(Continued)

Formula	Name	Solvent	d, C or %	$t, ^\circ C$	$[\alpha]_D$	Lit.
$C_{20}H_{24}O_7 \cdot H_2O$	Olivile hydrate.....	H_2O	0.314	12	-127	(1120.5)
$C_{21}H_{18}O_{12}$	Scutellarin.....	Py aq	3.79	18	-14.0	(731)
$C_{21}H_{28}O_8$	Olivile methylalcoholate.....	MeOH	6.35	22	-48.9	(1120.5)
$C_{21}H_{34}O_4$	Isopurganol.....	Py	0.70		-44.9	(1702)
$C_{21}H_{36}O_4$	Trifolianol.....	Py	1.472		-44.1	(1787)
		$CHCl_3$	1.059		-24.4	(1855)
$C_{22}H_{24}O_7$	Acetyltetramethylhematoxylin.....	AcOH	1.01	20	152.19	(863)
$C_{22}H_{24}O_{10}$	Homonataloin.....	H_2O	1.718	20	-102.7	(1188)
$C_{22}H_{28}O_7$	Dimethylolivile.....	EtOH	0.7687	24	56.4	(1120.5)
	Dimethylisoolivile.....	EtOH	0.4572	22.5	33.58	(1120.5)
$C_{22}H_{30}O_6$	Olivile ethylalcoholate.....	EtOH	0.730	28	-23.8	(1120.5)
$C_{23}H_{30}O_7$	Methylethylisoolivile.....	EtOH	1.355	25	39.36	(1120.5)
		EtOH	2.448	25	46.3	
	Ethylmethyisoolivile.....	EtOH	0.3045	25	50.35	
$C_{23}H_{40}O_4$	Ipuranol.....	Py	1.075	15	-37.2	(1703); cf. (1695)
$C_{24}H_{32}O_7$	Diethylisoolivile.....	EtOH	1.1342	22.5	38.2	(1120.5)
$C_{25}H_{24}O_{11}$	<i>d</i> -Catechin pentaacetate ($\lambda = 5790$).....	$C_2H_2Cl_4$	2.13		40.6	(670)
	<i>l</i> -Epicatechin pentaacetate.....	$C_2H_2Cl_4$	2.12		-15	
$C_{25}H_{38}O_6$	Diacetylipuranol.....	Py	1.25		-36.0	(1702)
$C_{25}H_{40}O_6$	Trifolianiyl diacetate.....	$CHCl_3$	1.561		-26.1	(1787)
		$CHCl_3$	0.9740		-25.7	(1708)
$C_{27}H_{42}O \cdot H_2O$	Ergosterol.....	$CHCl_3$			-126	(2003)
		Et_2O			-105.5	
$C_{28}H_{42}O_2$	Ergosteryl formate.....				-97.9	(2003)
$C_{29}H_{44}O_2$	Ergosteryl acetate.....				-91.8	(2003)
$C_{27}H_{44}O$	Cluytiasterol.....	$CHCl_3$	1.426		-52.6	(2051)
<i>Cholesterol and derivatives</i>						
$C_{27}H_{43}Br$	Cholesteryl bromide.....	C_6H_6	3.186	19.5	-19.14	(1122)
$C_{27}H_{43}Br_3$	Tribromocholestane.....	$CHCl_3$	3.352	19	-49.82	(1122)
$C_{27}H_{43}Cl$	Cholesteryl chloride.....	C_6H_6	3.09		-26.36	(1402)
$C_{27}H_{44}Cl_2$	Cholesteryl hydrochloride.....	C_6H_6	3.12		20.1	(1402)
		Et_2O	3.25		12.16	
$C_{27}H_{46}Br_2O$	Cholesterol dibromide.....		3.17		-41.6	(1402)
$C_{27}H_{46}Cl_2O$	Cholesterol dichloride.....		3.16		-29.1	(1402)
$C_{27}H_{45}Cl$	Chlorocholestane.....	$CHCl_3$	3.07	21	4.7	(1403)
$C_{27}H_{45}ClO$	Cholesterol hydrochloride.....	$H_2O?$	1.40		5.7	(1402)
$C_{27}H_{46}O$	Cholesterol.....	AcOEt	3.06	20	-25.64	(387)
		$CHCl_3$	2.1		-40.3	(1857)
		Et_2O	4.9		-29.92	(1402)
$C_{27}H_{46}O_2$	α -Cholesterol oxide.....	C_6H_6	1.71	20	-37.43	(2171.5)
$C_{27}H_{46}O_4$	Cholesterol ozonide.....	$CHCl_3$	3.88	20	14.51	(392.5)
$C_{27}H_{48}O$	β -Cholestanol.....	$CHCl_3$		18	27.4	(393)
$C_{27}H_{48}O$	γ -Cholestanol.....	Et_2O	2.63	18	29.9	(2193)
	δ -Cholestanol.....	$CHCl_3$	0.95	18	31.62	
$C_{27}H_{48}O$	Dihydrocholesterol.....	Et_2O	10		18.35	(1499)
		Et_2O	4	22	28.8	(2190)
$C_{29}H_{48}O_2$	Cholesteryl acetate.....	Et_2O	3.21		-29.8	(1402)
$C_{29}H_{48}Cl_2O_2$	Cholesteryl acetate dichloride.....	Et_2O	3.29		-32.8	(1402)
$C_{29}H_{48}Br_2O_2$	Cholesteryl acetate dibromide.....	Et_2O	3.11		-45.1	(1402)
$C_{33}H_{49}NO_2$	Cholesteryl phenylurethane.....	C_6H_6	2.08	19	-19.9	(153)
<i>Phytosterol and derivatives</i>						
$C_{20}H_{34}O$	Phytosterol (from colocynth seeds).....	$CHCl_3$	1.236		8.1	(1697)
$C_{27}H_{46}O$	Phytosterol.....	$CHCl_3$	1.196		-40.4	(1452)
		$CHCl_3$	0.9152		-34.4	(1708)
		$CHCl_3$	0.967		-33.6	(1706)
		$CHCl_3$	2.573		-30.1	
$C_{27}H_{46}O$	α -Phytosterol.....	$CHCl_3$	1.239		-41.7	(1787)
$C_{27}H_{46}O \cdot H_2O$	Phytosterol (verosterol).....	$CHCl_3$	1.19		-33.0	(1701)
$C_{28}H_{48}O \cdot H_2O$	(from <i>Tilia europaea</i>).....	$CHCl_3$	2.5752		-29.7	(1100)
	(from <i>Matricaria chamomilla</i>).....	$CHCl_3$	4.0356		-29.3	
	(from <i>Verbascum thapsus</i>).....	$CHCl_3$	1.2556		-3.3	
$C_{29}H_{48}O_2$	Phytosteryl acetate.....	$CHCl_3$	0.930		-43.9	(1787)

Phytosterol and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₃₀ H ₆₀ O ₂	Phytosteryl acetate (from <i>Linaria vulgaris</i>)..	CHCl ₃	2.5456		−38.61	(1100)
	(from <i>Tilia europaea</i>)...	CHCl ₃	2.5180		−37.9	
	(from <i>Verbascum thapsus</i>).....	CHCl ₃	2.504		−2.65	
C ₃₆ H ₆₂ O ₂	Phytosteryl benzoate (from <i>Linaria vulgaris</i>)	CHCl ₃	3.9074		−14.55	(1100)
<i>Sitosterol, coprosterol and derivatives</i>						
C ₂₇ H ₄₀ O ₂	Dehydrositostenedione.....	CHCl ₃			−38.9	(1635)
C ₂₇ H ₄₆ O	Sitosterol.....	CHCl ₃	1.509		−32.1	(1695)
		CHCl ₃	5.5		−34.4	(1635)
C ₂₇ H ₄₆ O	Sitosterol (from wheat germ).....	CHCl ₃	2.9		−32.2	(1857)
C ₂₇ H ₄₈ O	Coprosterol.....	CHCl ₃		20	24	(393)
		CHCl ₃	2.03	21	23.55	
C ₃₄ H ₆₁ NO ₂	Sitosteryl phenylcarbamate.....	C ₆ H ₆	3.90	19	−26.03	(1635)
<i>Withaninol, lippianol, fungisterin, laserpitin, bombicestrol, taraxasterol, ipuranol and derivatives</i>						
C ₂₆ H ₃₄ O ₆	Withaninol	CHCl ₃	1.872		91.2	(1709)
C ₂₆ H ₃₆ O ₄	Lippianol.....	EtOH	0.45		65	(1714)
C ₂₆ H ₄₀ O	Homotaraxasterol.....	CHCl ₃	0.494		25.3	(1694)
C ₂₆ H ₄₀ O.H ₂ O	Fungisterin.....	2% EtOH.CHCl ₃			−22.4	(2003)
		Et ₂ O			−12.9	
C ₂₆ H ₄₀ O ₇	Laserpitin.....	EtOH	8.11	18.5	118.84	(1460)
		EtOH	5.321	18.5	118.65	
C ₂₆ H ₄₄ O	Bombicestrol.....	CHCl ₃	15.9	15	−34	(1416)
C ₂₇ H ₄₂ O ₂	Acetylhomotaraxasterol.....	CHCl ₃	0.444		28.1	(1694)
C ₂₇ H ₄₂ O ₃	Fungisteryl acetate.....	CHCl ₃			−15.9	(2003)
		Et ₂ O			−10.8	
C ₂₇ H ₄₄ O ₂	Bombicesteryl formate.....	CHCl ₃	8.4	17.5	−47	(1416)
C ₂₇ H ₄₄ O ₆	Diacylipuranol.....	AcOEt	0.491	15	−25.4	(1703)
C ₂₈ H ₄₆ O ₂	Bombicesteryl acetate.....	CHCl ₃	15.0	17.5	−42.7	(1416)
C ₂₉ H ₄₈ O	Taraxasterol.....	CHCl ₃	2.171		96.3	(1694)
C ₃₁ H ₅₀ O ₂	Acetyltaraxasterol.....	CHCl ₃	1.023		122.2	(1694)
C ₃₃ H ₄₈ O ₂	Bombicesteryl benzoate.....	CHCl ₃	4.15	20	−14.63	(1416)
<i>α-Elaterin, anthesterol and derivatives</i>						
C ₂₈ H ₃₈ O ₇	α-Elaterin.....	CHCl ₃	1.560		−68.9	(1697)
C ₂₈ H ₄₈ O	Anthesterol.....	Xylene	2.3		44.7	(1097)
	α-Anthesterol.....	Xylene	2.13		54.1	
	β-Anthesterol.....	Xylene	2.13		48.3	
C ₂₈ H ₅₀ O	Anthesterol.....	C ₂ H ₄ Br ₂	0.753	17	48.3	(1096)
C ₃₁ H ₅₂ O	Anthesterol anhydride.....	CHCl ₃	2.5		75.4	(1099)
C ₃₁ H ₅₂ O.3H ₂ O	hydrate.....	CHCl ₃	2.5		69.3	(1099)
		CHCl ₃	2.5		91.2	(1099)
C ₃₃ H ₅₄ O ₂	Anthesteryl acetate (α-salt).....	CHCl ₃	2.5		91.2	(1099)
		CCl ₄	2.5		89.2	
		CHCl ₃	2.5		73.9	
		C ₆ H ₆	3.0		127.4	(1099)
		C ₆ H ₆	3.0		121.1	
C ₃₃ H ₅₃ BrO ₂	Bromanthesteryl acetate (α ₁ -salt).....	C ₆ H ₆	3.0		133.0	
		C ₆ H ₆	3.0		63.9	
		C ₆ H ₆	3.0		58.8	
		C ₆ H ₆	3.0		64.36	(1097)
		CCl ₄	2.5		71.7	
C ₃₆ H ₆₂ O ₂ .½H ₂ O	Anthesteryl β-benzoate.....	CCl ₄	2.5		66.7	
		CCl ₄	2.5		63.9	(1096)
		CCl ₄	1.25	16	59.9	
C ₃₆ H ₆₄ O ₂	Benzoylanthesterol.....	CCl ₄				
<i>Ledum camphor, micromeritol, amyirin, cedrol, faradiol and derivatives</i>						
C ₃₀ H ₃₀ CrO ₄	Ledum camphor ehromate (λ = 6708).....	CCl ₄	4		30.0	(2177)
C ₃₀ H ₄₆ O ₄	Micromeritol.....	CHCl ₃	0.217		61.4	(1707)
C ₃₀ H ₄₈ O ₂ .2H ₂ O	Oxy-α-amyirin.....	C ₆ H ₆	1.653	15.5	108.6	(2068)
C ₃₀ H ₄₉ BrO	Bromo-α-amyirin.....	C ₆ H ₆	2.59	16.3	72.8	(2068)
C ₃₀ H ₆₀ CrO ₄	Cedryl ehromate (λ = 6708).....	CCl ₄	5		79.4	(2177)
C ₃₀ H ₅₀ O	α-Amyirin.....	C ₆ H ₆	3.839	16.7	91.59	(2068); cf.
						(892,
						1032,
						1792)
C ₃₀ H ₅₀ O ₂	β-Amyirin.....	C ₆ H ₆	1.905	19	99.81	
		Me ₂ CO	1.254	20	45.1	(1098)

Ledum camphor, micromeritol, amylin, cedrol, faradiol and derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>c</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₃₂ H ₅₂ O ₂	α -Amyrin acetate.....	C ₆ H ₆	3.6		77.9	(1032); cf. (1792)
	α -Amyrin acetate.....	C ₆ H ₆	4.074	17.6	77.0	(2068)
	β -Amyrin acetate.....	C ₆ H ₆	4.15	16.7	78.6	
C ₃₃ H ₅₂ O ₄	Micromerol.....	EtOH	3.22		57	(1707)
C ₃₄ H ₅₄ O ₄	Faradiol acetate.....	C ₆ H ₆	4.0316	14	63.6	(1098)
C ₃₅ H ₅₄ O ₅	Micromeryl acetate.....	CHCl ₃	0.352		47.1	(1707)
C ₃₅ H ₅₈ O ₄	Faradiol propionate.....	C ₆ H ₆	3.0	20	62.3	(1098)
C ₃₇ H ₅₄ O ₂	α -Amyrin benzoate.....	C ₆ H ₆	3.4		93.58	(1032)
<i>Other alcohols and their derivatives</i>						
C ₃₁ H ₃₄ O ₁₄	Pentaacetylrrhapontin.....	AcOH	2	15	-11.6	(897)
C ₃₂ H ₄₄ O ₇	Somnirol.....	CHCl ₃	0.718		34.8	(1709)
C ₃₃ H ₃₅ O ₁₅	Hexaacetylrrhapontin.....	AcOH	2	15	-30.4	(897)
C ₃₃ H ₄₅ O ₇	Somnitol.....	CHCl ₃	1.216		21.2	(1709)
C ₃₅ H ₅₄ O ₅	Diacetylprunol.....	CHCl ₃	0.907		62.4	(1698)
C ₃₇ H ₄₄ O ₆	Dibenzoylcalabarol.....	CHCl ₃	2.947		14.7	(1855)
C ₃₇ H ₅₈ O ₉	Tetraacetylchytianol.....	AcOEt	0.988		-20.2	(1694)
C ₄₁ H ₃₉ ClO ₂₁ ·2H ₂ O	Delphinine chloride (λ = 6563).....	1% HCl	0.013		-1364.0	(2191)
	(λ = 6140).....	1% HCl	0.013		-2273.0	(2191)
C ₄₃ H ₅₈ O ₆	Caulosapogenin monomethyl ether.....	CHCl ₃	0.0706		74.4	(1710)
C ₅₅ H ₈₀ O ₂₅	Gegosaponin.....	90% EtOH	1.46		-39.15	(55)
C ₅₈ H ₉₂ O ₉	Caulophyllosapogenin dimethyl ether.....	CHCl ₃	0.612		43.6	(1710)
C ₅₆ H ₁₀₄ O ₁₇	Caulophyllosaponin.....	CHCl ₃	0.800		32.3	(1710)
C ₇₀ H ₈₂ O ₁₀	Tetrabenzoylcaulosapogenin.....	CHCl ₃	1.546		111.0	(1710)
<i>Aldehydes and Ketones</i>						
C ₁₅ H ₁₂ O ₆	Eriodictyonone.....	AcOEt	4.78	20	-28.21	(1463)
C ₁₅ H ₂₃ NO ₂	<i>d</i> -Longif-1, 2-dione monoxime.....	EtOH		30	121.3	(1949)
C ₁₅ H ₂₃ NO ₃	Tetrahydrosantonin oxime.....	CHCl ₃	1.057	15	-17.9	(2145)
		CHCl ₃	2.8	20	-17.78	(54)
C ₁₅ H ₂₄ O	β -Santalol.....		0.9909 ¹⁵		-41.53	(1872)
C ₁₅ H ₂₄ O ₂	<i>d</i> -Longif-1-ol-2-one.....	EtOH		30	100.8	(1949)
C ₂₁ H ₂₄ N ₂ O ₃	Artemisin hydrazone.....	95% EtOH	1.8128	24	180	(122)
		95% EtOH	2.2472	24	180	(122)
C ₂₄ H ₃₀ O ₅	Elatrone.....	CHCl ₃	1.092		120.5	(1451)
C ₃₀ H ₃₄ O ₆	Artemisone.....	AcOH	1.10	18.5	159	(124)
	Isoartemisone.....	EtOH	1.45	19.5	-157	(124)
		AcOH	1.06	13	-153	
C ₃₀ H ₄₅ O	Euphorbone.....	CHCl ₃	3.02	15	16.46	(427)
<i>Carboxylic Acids</i>						
<i>Picrotoxinonic, picrotinic acids and derivatives</i>						
C ₁₄ H ₁₅ O ₈	Picrotoxinonic acid.....	EtOH	2.515	17.5	102.38	(931)
C ₁₅ H ₁₅ BrO ₇ · $\frac{1}{2}$ H ₂ O	Bromopicrotoxic acid.....	EtOH	4.15	17	-96.38	(33)
C ₁₅ H ₁₇ BrO ₇	α -Bromopicrotoxininic acid.....	H ₂ O	2.82	17.5	-58.03	(928)
C ₁₅ H ₁₈ O ₇	α -Picrotoxininic acid.....	EtOH	5.99	17.5	-4.93	(928)
	β -Picrotoxininic acid.....	EtOH	9.25	17.5	-48.0	
C ₁₅ H ₁₈ O ₈	Picrotoxinonic acid methyl ether.....	EtOH	1.283	17.5	108.5	(931)
C ₁₅ H ₂₀ O ₇	Dihydropicrotoxininic acid.....	EtOH	3.01	17.5	-4.17	(928)
		EtOH	3.083	17.5	94.88	(931)
C ₁₅ H ₂₀ O ₈	α -Picrotinic acid.....	EtOH	3.909	17.5	73.3	(927)
	γ -Picrotinic acid.....	EtOH	2.096	17.5	4.23	(930)
	δ -Picrotinic acid.....	EtOH	4.099	17.5	71.58	
	Potassium γ -picrotinate.....	H ₂ O	9.287	17.5	-3.57	(930)
C ₁₅ H ₂₀ O ₇	Methyl α -picrotoxininate.....	EtOH	1.02	17.5	-9.73	(928)
	Methyl β -picrotoxininate.....	EtOH	1.05	17.5	-50.05	
C ₁₅ H ₂₀ O ₈	Methyl picrotoxinonate methyl ether.....	EtOH	1.149	17.5	111.50	(931)
C ₁₅ H ₂₂ O ₇	Methyl dihydropicrotoxininate.....	EtOH	2.584	17.5	70.26	(931)
C ₁₅ H ₂₂ O ₈	Methyl α -picrotinate.....	EtOH	2.790	17.5	79.15	(927)
	Methyl δ -picrotinate.....	EtOH	5.960	17.5	77.11	
C ₁₇ H ₂₂ O ₇	Ethyl α -picrotoxininate.....	EtOH	4.24	17.5	-8.07	(928)
	Ethyl β -picrotoxininate.....	EtOH	2.44	17.5	49.95	
C ₁₇ H ₂₄ O ₇	Ethyl dihydropicrotoxininate.....	EtOH	2.752	17.5	70.85	(931)
C ₁₇ H ₂₄ O ₈	Ethyl α -picrotinate.....	EtOH	4.082	17.5	78.60	(930)
	Ethyl δ -picrotinate.....	EtOH	6.025	17.5	74.25	(927)
C ₁₉ H ₂₈ O ₈	Diethyl picrotoxinindicarboxylate.....	EtOH	1.259	17.5	37.4	(929)

Santonin and related compounds

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₅ H ₁₈ Br ₂ O ₄	Dibromoparasantonin acid.....	EtOH	3.39		28.0	(622)
C ₁₅ H ₁₇ ClO ₃ ·H ₂ O	Chlorosantonin.....	50% EtOH	2	20	-54.75	(2148)
C ₁₅ H ₁₈ O ₃	Santonin.....	MeOH	2.065	15	-171.0	(2145)
C ₁₅ H ₁₈ O ₃	Parasantonide.....	CHCl ₃			891.7	(622, 622.5)
		CHCl ₃			744.6	
C ₁₅ H ₁₈ O ₄	δ-Hydroxysantonin.....	CHCl ₃	4	18	-108.62	(2148)
C ₁₅ H ₁₉ ClO ₅	Dihydrodihydroxyparasantonin acid chloro- hydrin.....	EtOH	0.62	25	-23.5	(622)
C ₁₅ H ₁₉ NO ₂	Parasantonimide.....	EtOH	2.67		1135	(622)
C ₁₅ H ₂₀ NO ₄	α-Santoninhydroxyoxime.....	90% EtOH	1.27	12	219.6	(624)
		96% EtOH	1.26	12	126.8	
C ₁₅ H ₂₀ N ₂ O ₇	α-Dinitrotetrahydrosantonin.....	CHCl ₃	0.971	15	105.0	(2145)
		CHCl ₃	1.053	15	90.2	
C ₁₅ H ₂₀ O ₄	Isosantonin acid.....	CHCl ₃			-73.92	(622)
C ₁₅ H ₂₀ O ₅	Hydroxyparasantonin acid.....	EtOH	3.27	27.2	89.8	(622)
C ₁₅ H ₂₀ O ₆	Dihydroxyparasantonin acid.....	EtOH	2.62	27.2	-31.55	(622)
C ₁₅ H ₂₀ O ₇	Santonin acid.....	EtOH	0.820	20	24.03	(2143)
		CHCl ₃	0.776	20	24.49	
C ₁₅ H ₂₁ BrO ₃	α-Monobromotetrahydrosantonin.....	CHCl ₃	1.650	15	9.09	(2145)
C ₁₅ H ₂₁ NO ₄	Hydroxamsantonin anhydride.....	EtOH	1.57	25	-214.33	(625)
C ₁₅ H ₂₂ N ₂ O ₄	α-Santoninhydroxylamineoxime.....	96% EtOH	8.98	12	47.41	(623)
		96% EtOH	8.82	12	-3.00	
C ₁₅ H ₂₂ O ₅	Santonic acid.....	EtOH	0.99	27	90.65	(625)
C ₁₅ H ₂₂ O ₃	Tetrahydrosantonin.....	CHCl ₃	4.37	25	60.56	(54)
		EtOH	1.366	15	23.4	(2145)
		CHCl ₃	1.070	15	28.0	
C ₁₆ H ₂₂ O ₅	Methyl hydroxyparasantonate.....	EtOH	1.51	25.6	36.4	(622)
C ₁₆ H ₂₃ N ₃ O ₄	Santonin acid semicarbazone.....	EtOH	1.68	25	13.39	(625)
C ₁₇ H ₂₁ NO ₃	Acetylparasantonimide.....	EtOH	1.30	25	697.2	(622)
C ₁₇ H ₂₂ O ₆	Acetoxyparasantonin acid.....	EtOH	0.62	25.7	64.3	(622)
C ₁₉ H ₂₇ ClO ₅	Ethyl dehydrodihydroxyparasantonate dichlorohydrin.....	EtOH	1.61	26	-97.0	(622)
C ₃₀ H ₄₀ N ₂ O ₆	Santonin acid hydrazone.....	AcOH	1.87	24.8	-86.75	(625)
Other Carboxy Compounds						
C ₈ H ₁₃ NO ₄	Cincholoiponic acid.....	H ₂ O	4	20	30.9	(2219); cf. (1882, 1959, 1964)
C ₁₂ H ₁₅ N	Tricycloeksantonic acid nitrile.....		0.990 ¹⁵		14.4	(1921)
C ₁₃ H ₁₄ O ₉ ·2H ₂ O	Glucogallic acid.....	very dil. Me ₂ CO	5.0	17	10.6	(449)
C ₁₃ H ₂₀ O ₂	Santalonic acid.....	90% EtOH	10	20	18.05	(284)
C ₁₄ H ₁₂ O ₉	<i>d</i> -Leucodigallic acid.....	EtOH	0.3246	17	56.4	(1515)
		H ₂ O	0.4124	19	104	
	<i>l</i> -Leucodigallic acid.....	EtOH	0.4004	18	-67.61	
		H ₂ O	0.4082	15	-64.58*	
C ₁₄ H ₂₇ NO ₃	Carpamic acid.....	H ₂ O	3.727		7.0	(87)
C ₁₅ H ₂₄ O ₄	<i>l</i> -α-Longiforic acid.....	EtOH		30	-23.47	(1949)
	<i>l</i> -β-Longiforic acid.....	EtOH		30	-49.3	
C ₁₆ H ₂₄ O ₂	Methyl vetivenate.....		1.0372 ²⁰	10	42.2	(1936)
C ₁₆ H ₂₈ O ₂	Hydnocarpic acid.....	C ₆ H ₆		20	70.0	(1195)
C ₁₆ H ₂₈ O ₂	Hydnocarpic acid.....	CHCl ₃	0.525		68.1	(1693)
C ₁₆ H ₂₉ NO	Hydnocarpamide.....	CHCl ₃	1.78		70.2	(1693)
C ₁₇ H ₃₀ O ₂	Methyl hydnocarpate.....	CHCl ₃	3.93		62.4	(1693)
C ₁₈ H ₁₆ O ₇	<i>d</i> -Usnic acid.....	CHCl ₃	2.07	11.5	49.5	(2174)
C ₁₈ H ₃₂ O ₂	Ethyl hydnocarpate.....	CHCl ₃	2.04		51.6	(1693)
C ₁₉ H ₂₂ O ₇ ·3H ₂ O	Matairesinolic acid (a) anhydrous.....	Me ₂ CO	14.45	20	-3.46	(405)
	(b) hydrated.....	Me ₂ CO	14.45	20	-3.04	
	(c) lactone.....	Me ₂ CO	14.45	20	-3.65	
C ₂₀ H ₁₈ O ₅	Isocubebic ether.....	C ₆ H ₆	2.48		26.02	(1367)
C ₂₀ H ₁₈ O ₆	Cubebinolide.....	CHCl ₃	4.141	16	33.69	(1367)
C ₂₀ H ₃₀ O ₅	Andrographolide.....	AcOH	2	26	-126	(742)
C ₂₀ H ₃₂ O ₆	Andrographolic acid.....	MeOH	2.466	26	14.4	(742)

*Mutarotation.

Other Carboxy Compounds.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>c</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₂₁ H ₂₁ ClO ₆	Cubebinolide hydrochloride methyl ester....	CHCl ₃	4.79	16	13.9	(1367)
C ₂₁ H ₂₈ O ₄	Marrubiin.....	Me ₂ CO	4.79	24	45.68	(737)
C ₂₁ H ₃₀ O ₅	Marrubic acid.....	Me ₂ CO	2.55	21.5	7.86	(737)
C ₂₃ H ₃₈ O ₇	Elateric acid.....	AcOEt	1.60		23.9	(1451)
C ₂₄ H ₂₁ NO ₆	<i>d</i> -Usnic anilide.....	CHCl ₃	2.53	16	28.6	(2174)
C ₂₄ H ₂₂ O ₁₄	<i>d</i> -Pentaacetyl-leucodigallic acid.....	Me ₂ CO	0.2824	18	76.4	(1515)
C ₂₄ H ₂₈ O ₆	Casimiroside.....	CHCl ₃	1.542		-49.2	(1695)
C ₂₄ H ₃₀ O ₇	Casimiroic acid.....	EtOH	0.835		-86.8	(1695)
C ₂₄ H ₃₄ O ₂	Cholanetriene-carboxylic acid.....	CHCl ₃	4.83	20	-19.7	(2175)
C ₂₄ H ₄₀ O ₂	Cholanecarboxylic acid.....	CHCl ₃	6.51	20	20.3	(2175)
C ₂₄ H ₄₀ O ₄	Desoxycholic acid.....	EtOH	6.64	20	53.28	(1166)
C ₂₄ H ₄₀ O ₄	Choleinic acid.....	EtOH	4.84	20	47.97	(1166)
C ₂₆ H ₄₂ NO ₆ Na	Glycocholic acid, sodium salt.....	H ₂ O	8.44	13	24.3	(1203)
		90% EtOH	2.42		27.8	
C ₂₆ H ₄₃ NO ₆	<i>d</i> -Glycocholic acid.....	96% EtOH	1.79	7	32.3	
C ₂₇ H ₄₆ NO ₆	Glycocholic acid.....	Et ₂ O	4		4.57	(1646)
C ₃₀ H ₄₂ O ₉	Photosantoninic acid.....	EtOH	1.99	15	-9.88	(626)
C ₃₂ H ₂₈ O ₅	Diphenylcubebinolide.....	CHCl ₃	5.97	16	-178.8	(1367)
C ₃₂ H ₃₆ O ₂₁	<i>d</i> -Hexacarbethoxy-leucodigallic acid.....	EtOH	0.3964	18	62.5	(1515)
	<i>l</i> -Hexacarbethoxy-leucodigallic acid.....	EtOH	0.3648	15	-57.35	
C ₃₂ H ₃₈ O ₁₉	Chlorogenic acid.....	H ₂ O	2.75	26	-35.2	(744)

Nitrogen Compounds, Mainly Alkaloids

Morphine (C₁₇H₁₉NO₃) and related compounds

C ₁₇ H ₁₈ BrNO ₂	Bromomorphide.....	MeOH	2.837	25	65.9	(1895)
C ₁₇ H ₁₈ ClNO ₂	β -Chloromorphide.....	MeOH	3.975	15	-5	(1108)
C ₁₇ H ₁₈ ClNO ₂	Chloromorphide.....	MeOH	0.573		-375.2	(1895)
C ₁₇ H ₁₉ Cl ₂ NO ₂	Chloromorphide hydrochloride.....	H ₂ O	1.67	20	-315.3	(1895)
C ₁₇ H ₁₉ Br ₂ NO ₂	Bromomorphide hydrobromide.....	H ₂ O	3.157	27	41.1	(1895)
C ₁₇ H ₁₉ BrClNO ₂	Chloromorphide hydrobromide.....	H ₂ O	1.65	19	-268.6	(1895)
C ₁₇ H ₁₉ NO ₃	Isomorphine.....	MeOH	2.01	25	-164.3	(1895)
C ₁₇ H ₁₉ NO ₃	α -Isomorphine.....	MeOH	2.95	15	-167	(1534)
	β -Isomorphine.....	MeOH	1.63	17	-216	(1896)
	γ -Isomorphine.....	MeOH	1.795	15	-94	
C ₁₇ H ₂₀ BrNO ₃	Isomorphine hydrobromide.....	H ₂ O	2.49	15	-127.2	(1895)
	γ -Isomorphine hydrobromide.....	H ₂ O	1.885	15	-71	(1534)
C ₁₇ H ₂₀ ClNO ₂	Desoxymorphine hydrochloride.....	H ₂ O?	2.36	27	140.3	(1895)
C ₁₇ H ₂₀ ClNO ₃	Neoisomorphine hydrochloride.....	H ₂ O	1.84		-79.1	(1184)
	β -Isomorphine hydrochloride.....	H ₂ O	2.26	11	-200.8	(1896)
	γ -Isomorphine hydrochloride.....	H ₂ O	1.888	15	-76	(1534)
C ₁₈ H ₁₉ NO ₂	Apomorphine 3-methyl ether.....	EtOH	8.4	15	-90	(1113)
		CHCl ₃	2.6	15	-103	
C ₁₈ H ₁₉ NO ₂	Methylapomorphine.....	EtOH	1.06	22	66.83	(1726)
C ₁₈ H ₂₂ INO ₃	Morphine methiodide.....	H ₂ O	1.162	25	-72.9	
	Isomorphine methiodide.....	H ₂ O	1.696	23	-91.5	(1895)
	γ -Isomorphine methiodide.....	H ₂ O	1.540	15	-50	(1534)
	Neoisomorphine methiodide.....	H ₂ O	1.56		-54.5	(1184)
C ₁₉ H ₂₁ NO ₂	Apomorphine dimethyl ether.....	EtOH	1.639	15	-148	(1113)
C ₁₉ H ₂₂ BrNO ₃	Bromo- α -methylmorphimethine.....	EtOH	1.23	15	-104.06	(2075)
	Bromo- β -methylmorphimethine.....	EtOH	0.713	15	128.22	
C ₁₉ H ₂₂ INO ₂	Methylapomorphine methiodide.....	MeOH	1.257	15	-20	(1113)
		H ₂ O	0.952	21	10.48	(1726)
C ₁₉ H ₂₂ NIO ₂	Dimethylapomorphine hydroiodide.....	EtOH	1.379	15	-49	(1113)
C ₁₉ H ₂₃ NO ₃	β -Methylmorphimethine.....	EtOH	1	17	438	(1114)
	δ -Methylmorphimethine.....	MeOH	1.24	15	256.6	
	γ -Methylmorphimethine.....	CHCl ₃	3.09	20	64.6	
		CHCl ₃	0.574	20	67	(1725)
	ϵ -Methylmorphimethine.....	99% EtOH		15	-120.1	(1104)
	δ -Methylmorphimethine.....	EtOH	8.91	15	-174	(1110)
C ₁₉ H ₂₄ ClNO ₃	ϵ -Methylmorphimethine hydrochloride.....	H ₂ O		15	-154	(1104)
C ₁₉ H ₂₄ INO ₃	γ -Methylmorphimethine hydroiodide.....	H ₂ O	0.811	20	37	(1725)
	ϵ -Methylmorphimethine hydroiodide.....	H ₂ O	0.805	20	-95.6	
C ₂₀ H ₂₄ INO ₂	Dimethylapomorphine methiodide.....	H ₂ O	2.67	21	-42.03	(1726)
C ₂₀ H ₂₆ BrINO ₃	Bromo- α -methylmorphimethine methiodide.....	EtOH	0.56	15	-110.71	(2075)

Morphine (C₁₇H₁₉NO₃) and related compounds.—(Continued)

Formula	Name	Solvent	<i>d</i> , C or %	<i>t</i> , °C	[α] _D	Lit.
C ₂₀ H ₂₅ NO ₃	α-Dimethylmorphimethine.....	MeOH	2.085	24	−251.9	(1724)
C ₂₀ H ₂₆ INO ₃	α-Methylmorphimethine methiodide.....	H ₂ O	10	17	−12.7	(1106)
	β-Methylmorphimethine methiodide.....	97% EtOH	0.6	17	233	(1106)
	γ-Methylmorphimethine methiodide.....	H ₂ O	1.56	17	34.7	(1896)
	δ-Methylmorphimethine methiodide.....	EtOH	1.00	15	150.7	(1106)
	ε-Methylmorphimethine methiodide.....	H ₂ O	0.951	20	−110.4	(1725)
		H ₂ O			−111	(1104)
	ζ-Methylmorphimethine methiodide.....	H ₂ O	2.486	15	−148	(1110)
C ₂₁ H ₂₆ NO ₄	Acetylmethylmorphimethine.....	CHCl ₃	5.66	21	150	(1111)
C ₂₁ H ₂₈ INO ₃	α-Dimethylmorphimethine methiodide.....	H ₂ O	0.260	23	−134.4	(1724)
	β-Dimethylmorphimethine methiodide.....	H ₂ O	0.229	22	268.5	
		H ₂ O	0.213	22	278.5	
	γ-Dimethylmorphimethine methiodide.....	H ₂ O	0.642	20	14	(1724, 1725)
	δ-Dimethylmorphimethine methiodide.....	H ₂ O	0.146	28	171	(1724)
	ε-Dimethylmorphimethine methiodide.....	H ₂ O	0.283	20	−79	
C ₂₂ H ₂₆ INO ₅	Diacetylmorphine methiodide.....	H ₂ O	0.896	15	−107	(1534)
	Diacetyl-γ-isomorphine methiodide.....	H ₂ O	1.273	15	−24	(1534)
C ₂₂ H ₂₈ BrNO ₅	Bromoacetoxydihydro-α-dimethylmorphi- methine methyl ether.....	MeOH	2.468	26	108.4	(1723)
C ₂₂ H ₂₈ INO ₄	Acetyl-ε-methylmorphimethine methiodide..	H ₂ O			−45	(1104)
C ₂₆ H ₂₉ NO ₅	α-Methylmorphinemethine benzoate.....	H ₂ O	1.0	16	−112.8	(1106)
	β-Methylmorphimethine benzoate.....	H ₂ O	1	17	254	(1106)
	δ-Methylmorphimethine benzoate.....	EtOH	0.63	15	181.1	(1106)
	γ-Methylmorphimethine benzoate.....	99% EtOH	0.87	15	41.3	(1106)
C ₃₁ H ₂₅ NO ₄	Dibenzoylapomorphine.....	CHCl ₃	3.33	17	43.44	(1726)
<i>Codeine (methylmorphine), thebaine (dimethylmorphine) and related compounds</i>						
C ₁₈ H ₁₉ NO ₃	Codeinone.....	EtOH	1.007	15	−205	(21)
C ₁₈ H ₁₉ NO ₃	Isocodeinone.....	99% EtOH	2.11	15	−25	(1107)
C ₁₈ H ₂₀ ClNO ₂	β-Chlorocodide.....	EtOH	0.824	15	−10	(1108)
	Chloro-ψ-codeine.....	99% EtOH		15	−100.8	(1104)
C ₁₈ H ₂₀ BrNO ₃	Bromo-ψ-codeine.....	EtOH		15	−75.2	(1104)
C ₁₈ H ₂₀ INO ₂	Iodocodide.....	CHCl ₃	3.95	20	136.5	(1105)
C ₁₈ H ₂₀ N ₂ O ₃	Codeinone oxime.....	EtOH	0.139	15	−499	(21)
C ₁₈ H ₂₀ N ₂ O ₅	Nitro-ψ-codeine.....	CHCl ₃		15	−49.9	(1104)
C ₁₈ H ₂₁ NO ₂	Desoxycodine.....	EtOH	4.922	15	121	(1115)
C ₁₈ H ₂₁ NO ₃	Codeine.....	97% EtOH	5.0	15	−135.8	(885.5); cf. (784.5)
		CHCl ₃	2	15	−111.5	
		CHCl ₃	4	23	−115.63	(901)
	Allo-ψ-codeine.....	EtOH	4.5	15	−228	(1110)
	ψ-Codeine.....	EtOH	1.91		−91.1	(1417)
	Neoisocodeine.....	EtOH	3.53		−96.6	(1184)
	Isocodeine.....	CHCl ₃	1.87		−150.6	
C ₁₈ H ₂₁ NO ₄	Codeine oxide.....	H ₂ O	2.08	18	−97.1	(1466)
C ₁₈ H ₂₁ NO ₅ S	β-Codeinesulfonic acid.....	H ₂ O	3.024	20	−190.1	(1675)
		N KOH	4.23	20	−136.3	
C ₁₈ H ₂₁ NO ₇ S	Codeinehydroxysulfonic acid.....	2N KOH	4.17	20	−115.4	(675)
C ₁₈ H ₂₂ ClNO ₃ ·2H ₂ O	Codeine hydrochloride.....	H ₂ O	2	22.5	−108.2	(881.2, 2053)
C ₁₈ H ₂₂ ClNO ₄	Codeine oxide hydrochloride.....	H ₂ O	2.08	20	−105.8	(1466)
C ₁₈ H ₂₂ INO ₃	Allo-ψ-codeine hydroiodide.....	EtOH	1.967	15	−153	(1110)
	ψ-Codeine hydroiodide.....			15	−57	
C ₁₈ H ₂₃ NO ₂	Desoxydihydrocodeine.....	EtOH	5.171	15	−24	(1115)
C ₁₈ H ₂₄ ClNO ₂	Desoxydihydrocodeine hydrochloride.....	H ₂ O	5.289	15	−17	(1115)
C ₁₉ H ₂₂ INO ₃	Isocodeinone methiodide.....	H ₂ O	0.893	15	−12	(1107)
C ₁₉ H ₂₁ NO ₃	Thebaine.....	CHCl ₃	5	22.5	−229.5	(885.5)
		97% EtOH	2	15	−218.6	
C ₁₉ H ₂₂ ClNO ₃	Thebaine hydrochloride.....	H ₂ O	2	22.5	−163.25	(885.5)
C ₁₉ H ₂₃ ClNO ₂	ψ-Chlorocodide methiodide.....				−227.4	(1104)
C ₁₉ H ₂₃ INO ₃	β-Isocodeine methiodide.....	H ₂ O	0.603		−145.5	
C ₁₉ H ₂₄ INO ₃	Allopseudocodeine isomethiodide.....	H ₂ O	1.728	15	−142	(1110)
C ₁₉ H ₂₅ NO ₇ S	Methylhydroxycodinesulfonic acid.....	H ₂ O	1.76	20	−63.2	(675)

Codeine (methyilmorphine), thebaine (dimethyilmorphine) and related compounds.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₂₀ H ₂₃ NO ₄	Acetocodeine.....	CHCl ₃	4.579	21	−141	(1111)
C ₂₀ H ₂₆ INO ₂	Methyldesoxycodine methiodide.....	EtOH	2.290	15	108	
C ₂₀ H ₂₆ INO ₃	Methylcodeine methiodide.....	H ₂ O	0.6013	22	−107.2	(1724)
C ₂₀ H ₂₈ INO ₂	Methyldesoxydihydrocodeine methiodide....	99% EtOH	2.773	15	−12	(1115)
C ₂₁ H ₂₆ INO ₄	Acetylcodeine methiodide.....	H ₂ O	1.03	15	−64	(1111)
C ₂₂ H ₂₅ NO ₅	Acetoacetylcodeine.....	CHCl ₃	5.72	17	−207	(1111)
	Acetoacetyl-ψ-codeine.....	CHCl ₃	5.49	18	−126	(1112)
	Acetoacetylisocodeine.....	CHCl ₃	5.15	14	−236	(1112)
C ₂₆ H ₂₆ NO ₄	Desoxycodine benzoate.....	EtOH	5.53	15	106	(1115)
C ₂₆ H ₂₇ NO ₃	Pseudocodeine <i>p</i> -cresyl ether.....	CHCl ₃	2.78	20	−13.7	(1105)
C ₂₆ H ₂₇ NO ₄	Pseudocodeine guaiacyl ether.....	CHCl ₃	0.9610	20	−22.9	(1105)
C ₂₇ H ₂₇ NO ₅	Codeine phenylpropionate.....	CHCl ₃	4	23	−51.00	(901)
		CHCl ₃	1	23	−50.50	
		H ₂ O	1	22	−76.00	
C ₂₇ H ₂₉ NO ₅	Codeine cinnamate.....	CHCl ₃	4	23	−51.63	(901)
		CHCl ₃	1	23	−52.50	
		H ₂ O	1	22	−75.00	
C ₂₇ H ₃₁ NO ₅	Codeine β-phenylpropionate.....	CHCl ₃	4	23	−64.37	(901)
		H ₂ O	1	22	−88.00	
C ₃₆ H ₄₄ N ₂ O ₉	Bimolecular codeine oxide.....	H ₂ O	2.51	20	−97.6	(1466)
		EtOH	2.51	19	−105.9	
	Hydrated.....	H ₂ O	2.46	20	−99.5	(1466)
		EtOH	2.50	19	−107.2	
C ₃₆ H ₄₄ N ₂ O ₁₀ ·5.5H ₂ O	Codeine sulfate.....	H ₂ O	3	25	−100.9	(885.5)
C ₄₀ H ₄₄ N ₂ O ₁₀	Codeine acetylenedicarboxylate.....	CHCl ₃	4	22	−76.62	(901)
		CHCl ₃	1	22	−68.00	
		H ₂ O	1	22	−87.50	
C ₄₀ H ₄₆ N ₂ O ₁₀	Codeine fumarate.....	CHCl ₃	4	22	−81.50	(901)
		CHCl ₃	1	22	−83.00	
		H ₂ O	1	22	−90.00	
C ₄₀ H ₄₆ N ₂ O ₁₀	Codeine maleate.....	CHCl ₃	4	22	−80.75	(901)
		CHCl ₃	1	22	−80.00	
		H ₂ O	1	22	−93.00	
C ₄₀ H ₄₈ N ₂ O ₁₀	Codeine succinate.....	CHCl ₃	4	23	−87.75	(901)
		CHCl ₃	1	23	−90.00	
		H ₂ O	1	25	−103.00	
<i>Cinchonine, cinchonidine and their derivatives; cf. (866, 875, 876, 885.5, 1026, 1027, 1028, 1030, 1187, 1196, 1543.5, 1794, 1963, 2070, 2223, 2223.5)</i>						
C ₁₉ H ₂₁ BrN ₂ O	Bromocinchonidine.....	33% EtOH.CHCl ₃	2	17	−110.3	(290)
C ₁₉ H ₂₁ BrN ₂ O	Bromocinchonine.....	33% EtOH.CHCl ₃	2.03	17	185.7	(289)
C ₁₉ H ₂₁ ClN ₂	Cinchonine chloride.....	EtOH	1.975	13	57.7	(1756)
		CHCl ₃	2.007	13	62.2	
C ₁₉ H ₂₁ ClN ₂ ·2H ₂ O	Hydrated.....	EtOH	2.009	13	49.77	
C ₁₉ H ₂₁ ClN ₂	Cinchonidine chloride.....	EtOH	2.020	13	78.2	(1756)
		CHCl ₃	2.009	13	90.9	
C ₁₉ H ₂₂ Br ₂ N ₂ O	β-Cinchonine dibromide.....	33% EtOH.CHCl ₃	1.0	17	107.5	
C ₁₉ H ₂₂ Br ₂ N ₂ O	β-Cinchonidine dibromide.....	33% EtOH.CHCl ₃	2.1	17	−135	(291)
C ₁₉ H ₂₂ Cl ₂ N ₂	Cinchonidine chloride monohydrochloride....	H ₂ O	1.573	24	24.16	(1756)
C ₁₉ H ₂₂ Cl ₂ N ₂	Cinchonine chloride monohydrochloride.....	H ₂ O	1.555	22	48.86	(1756)
C ₁₉ H ₂₂ N ₂ O	Cinchonine.....	CHCl ₃	0.560	17	209.6	(1540)
		EtOH	0.6060	20	225.2	(1756)
C ₁₉ H ₂₂ N ₂ O	Cinchonidine; cf. (329, 875, 876, 885.5, 1196, 1540, 1784).....	EtOH	0.878	11	−111.0	(1756)
		CHCl ₃	1.095	14	−86.7	
C ₁₉ H ₂₂ N ₂ O	Isocinchonidine; for various isomerides, cf. (866, 875).....	CHCl ₃	1.96		−128	(1554)
		97% EtOH	2.99		−129	
C ₁₉ H ₂₂ N ₂	Desoxycinchonine.....	EtOH	1.965	20	181.2	(1756)
		CHCl ₃	2.030	13	194.3	
C ₁₉ H ₂₂ N ₂	Desoxycinchonidine.....	EtOH	2.006	13	−29.9	
		CHCl ₃	2.006	13	−19.7	

Cinchonine, cinchonidine and their derivatives; cf. (866, 875, 876, 885.5, 1026, 1027, 1028, 1030, 1187, 1196, 1543.5, 1794, 1963, 2070, 2223, 2223.5).—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₉ H ₂₂ N ₂ O	Apocinchonidine.....	EtOH	0.8	15	−129.2	
	β-Cinchonidine.....	EtOH	0.5	20	−171.5	
	γ-Cinchonidine.....	EtOH	0.5	20	−164.6	(875, 1512)
C ₁₉ H ₂₂ N ₂ O	Hydrocinchoninone.....	EtOH	4.12	21	75.8	(1045)
C ₁₉ H ₂₃ ClN ₂ O	Cinchonine hydrochloride.....	CHCl ₃	1.407	23	132.9	(1756)
C ₁₉ H ₂₃ ClN ₂ O	Cinchonidine hydrochloride (other salts; cf. (1540, 1543, 2235)).....	CHCl ₃	2.85	15	−24.2	(885.5); cf.
C ₁₉ H ₂₃ ClN ₂ O.H ₂ O	Hydrated.....	97% EtOH	3	15	−108.0	(1540)
		2 <i>N</i> HCl	10	20	−142.1	(876)
C ₁₉ H ₂₃ IN ₂ O	Isocinchonidine hydroiodide.....	CHCl ₃	2.0		−58	(1554)
		97% EtOH	3.03		−58	
C ₁₉ H ₂₃ N ₃ O ₄	Cinchonine nitrate.....	H ₂ O	1.54	17	−99.9	(1540)
		EtOH	1.54	17	−103.2*	
C ₁₉ H ₂₄ Cl ₂ N ₂ O	Cinchonine dihydrochloride.....	H ₂ O	3.67	20.8	205.5	(1445)
		H ₂ O	3.55	84	192.8	
		H ₂ O	3	15	206.1	(885.5)
C ₁₉ H ₂₄ N ₂ O	Cinchonamine; cf. (46, 46.5, 881).....	EtOH	2		120	(934)
		97% EtOH	2	15	121.1	(882)
C ₁₉ H ₂₄ N ₂ O	Hydrocinchonine.....	EtOH	0.406	12	192.1	(1756)
C ₁₉ H ₂₄ N ₂ O	Hydrocinchonidine.....	97% EtOH	2	15	−98.4	(875.5); cf. (880)
C ₁₉ H ₂₄ N ₂ O ₅ S	Cinchonine hydrogen sulfate.....	H ₂ O	3.92	20.8	195.0	(1445)
		H ₂ O	3.77	89.3	175.5	
C ₁₉ H ₂₄ N ₂ O ₅ S	Cinchonidine hydrogen sulfate.....	80% EtOH	2	15	−109.0	(885.5)
C ₁₉ H ₂₈ N ₂ O	Hexahydrocinchonine.....	EtOH	17.8	20	170.2	(1957)
C ₁₉ H ₂₈ N ₂ O	Hexahydrocinchonidine.....	EtOH	4.8	17	−82	
C ₁₉ H ₃₄ N ₂ O	Dodecahydrocinchonidine.....	EtOH	3.75	17	−51	(1957)
C ₂₀ H ₂₂ N ₂ O ₃	Acetylkinchoninal.....	CHCl ₃	1	21	28.2	(1917)
C ₂₀ H ₂₄ N ₂ O	Methylcinchotoxine.....	CHCl ₃	2.23	20	35.28	(1757)
C ₂₁ H ₂₄ N ₂ O ₂	Acetylkinchonine.....	H ₂ O	2	15	139.5	(1917)
		3 <i>N</i> HCl.CHCl ₃	1.18	16.8	110.4	
C ₂₁ H ₂₈ Cl ₂ N ₂ O	Ethylcinchotoxine dihydrochloride.....	H ₂ O	0.38	15	51.75	(351)
C ₂₃ H ₂₄ N ₂ O ₅	Cinchonine acetylenedicarboxylate.....	CHCl ₃	4	22	119.75	(901)
		CHCl ₃	1	22	133.50	
		H ₂ O	0.5	22	137.00	
C ₂₃ H ₂₈ N ₂ O ₅	Cinchonine succinate.....	CHCl ₃	4	22	159.0	(901)
		CHCl ₃	1	22	165.0	
		H ₂ O	0.5	23	140	
C ₂₃ H ₂₆ N ₂ O ₅	Cinchonine fumarate.....	CHCl ₃	4	22	145.63	(901)
		CHCl ₃	1	22	140.00	
		H ₂ O	0.5	22	139.00	
C ₂₃ H ₂₆ N ₂ O ₅	Cinchonine maleate.....	CHCl ₃	4	22	117.75	(901)
		CHCl ₃	1	22	125.00	
		H ₂ O	0.5	23	143	
C ₂₅ H ₂₄ N ₂ O ₃	Benzoylcinchoninal.....	CHCl ₃	1	22.2	−72.4	(1917)
C ₂₅ H ₂₈ N ₂ O ₃ S	Cinchonine benzenesulfinate.....	CHCl ₃	5	23	111.4	(903)
		CHCl ₃	2.5	23	123.6	
C ₂₅ H ₂₈ N ₂ O ₄ S	Cinchonine benzenesulfonate.....	CHCl ₃	5	21	90.2	(903)
C ₂₆ H ₂₆ N ₂ O ₂	Benzoylcinchonine.....	H ₂ O	1	20.2	−24.7	(1917)
C ₂₆ H ₂₈ N ₂ O ₃	Cinchonine monobenzoate.....	CHCl ₃	5	21	141.1	(902)
C ₂₆ H ₂₈ N ₂ O ₄	Cinchonine monosalicylate.....	CHCl ₃	5	21	142.3	(901)
		CHCl ₃	2.5	21	157.8	
C ₂₆ H ₂₈ N ₃ O ₃	Cinchonine anthranilate.....	CHCl ₃	5	21	162.8	(902)
		CHCl ₃	2.5	21	176.6	
C ₂₆ H ₃₀ N ₂ O ₃ S	Cinchonine <i>p</i> -toluenesulfinate.....	CHCl ₃	5	21	100.3	(903)
		CHCl ₃	2.5	21	107.6	
C ₂₆ H ₃₀ N ₂ O ₄ S	Cinchonine <i>p</i> -toluenesulfonate.....	CHCl ₃	5	21	94.6	(903)
		CHCl ₃	2.5	21	99.0	
C ₂₇ H ₃₂ N ₂ O ₃ S	Cinchonine <i>p</i> -xylene-2-sulfinate.....	CHCl ₃	5	21	114.2	(903)
		CHCl ₃	2.5	21	120.2	

* Calculated on weight of alkaloid.

Cinchonine, cinchonidine and their derivatives; cf. (866, 875, 876, 885.5, 1026, 1027, 1028, 1030, 1187, 1196, 1543.5, 1794, 1963, 2070, 2223, 2223.5)—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
C ₂₇ H ₃₂ N ₂ O ₄ S	Cinchonine <i>p</i> -xylene-2-sulfonate.....	CHCl ₃	5	21	97.2	(903)
		CHCl ₃	2.5	21	103.8	
C ₂₈ H ₂₈ N ₂ O ₃	Cinchonine phenylpropionate.....	CHCl ₃	4	23	86.00	(901)
		CHCl ₃	1	23	100.0	
		H ₂ O	0.5	23	92.0	
C ₂₈ H ₃₀ N ₂ O ₃	Cinchonine cinnamate.....	CHCl ₃	4	23	107.0	(901)
		CHCl ₃	1	23	121.50	
		H ₂ O	0.5	23	117.00	
C ₂₈ H ₃₀ N ₂ O ₆	Cinchonine acetylsalicylate.....	CHCl ₃	5	21	135.0	(901)
C ₂₈ H ₃₁ N ₃ O ₄	Cinchonine acetylthranilate.....	CHCl ₃	5	21	125.8	(902)
		CHCl ₃	2.5	21	141.2	
C ₂₈ H ₃₂ N ₂ O ₃	Cinchonine di-β-phenylpropionate (other salts; cf. (1946)).....	CHCl ₃	5	21	116.2	(902)
		CHCl ₃	2.5	21	120.5	
C ₂₈ H ₃₂ N ₂ O ₃	Cinchonine β-phenylpropionate.....	EtOH	0.5	23	222.0	(901)
		CHCl ₃	4	23	116.25	
		CHCl ₃	1	23	125.00	
		H ₂ O	0.5	23	98.00	
C ₂₉ H ₃₀ Cl ₂ N ₂ O	α-Naphthyleinechotoxine dihydrochloride....	H ₂ O	0.21	15	49.6	(351)
C ₂₉ H ₃₆ N ₂ O ₄ S	Cinchonidine <i>dl</i> - <i>sec</i> -butylbenzenesulfonate..	MeOH	1	20	-7.34	(1088)
C ₃₁ H ₃₂ N ₂ O ₄ S	Cinchonine phenetylsulfinate.....	CHCl ₃	5	21	101.2	(903)
		CHCl ₃	2.5	21	104.2	
C ₃₁ H ₃₂ N ₂ O ₆ S	Cinchonine phenetylsulfonate.....	CHCl ₃	5	21	98.1	(903)
		CHCl ₃	2.5	21	105.4	
C ₃₃ H ₃₂ N ₂ O ₆	Cinchonine benzoylsalicylate.....	CHCl ₃	5	21	137.3	(901)
		CHCl ₃	2.5	21	156.0	
C ₃₃ H ₃₄ N ₂ O ₆	Cinchonine dibenzoate.....	CHCl ₃	5	21	151.0	(902)
C ₃₃ H ₃₄ N ₃ O ₄	Cinchonine benzoylanthranilate.....	CHCl ₃	5	21	144.2	(902)
		CHCl ₃	2.5	21	161.8	
C ₃₃ H ₃₄ N ₄ O ₆	Cinchonine dianthranilate.....	CHCl ₃	5	21	161.4	(902)
C ₃₅ H ₃₈ N ₂ O ₆	Cinchonine diphenylacetate.....	CHCl ₃	5	21	107.0	(902)
		CHCl ₃	2.5	21	109.0	
C ₃₇ H ₃₆ N ₄ O ₆	Cinchonine diacetylanthranilate.....	CHCl ₃	5	21	111.3	(902)
C ₃₈ H ₄₆ N ₄ O ₆ S	Cinchonine sulfate.....	97% EtOH	10	15	189.45	(885.5)
C ₃₈ H ₄₆ N ₄ O ₆ S	Cinchonidine sulfate, anhydrous.....	1.294 <i>N</i> H ₂ SO ₄	3	19	153.0	(1658)
C ₃₈ H ₄₆ N ₄ O ₆ S.6H ₂ O	Hydrated.....	H ₂ O	1.06	15	-106.77	(1540)
		H ₂ O	2	15	-110.5	
C ₃₈ H ₄₆ N ₄ O ₆ S.7H ₂ O		1.294 <i>N</i> H ₂ SO ₄	3	19	132.2	
C ₄₀ H ₄₆ N ₄ O ₆	Cinchonine oxalate.....	EtOH + CHCl ₃	2.0	15	-98.7	(885.5)
C ₄₇ H ₄₆ N ₄ O ₇	Cinchonine dibenzoylanthranilate.....	CHCl ₃	5	21	113.8	(902)
<i>Quinine and isomerides (C₂₀H₂₄N₂O₂) and their derivatives</i>						
C ₁₉ H ₂₂ N ₂ O ₂	Apoquinine.....	97% EtOH	2	15	-178.1	(875); cf. (1261)
		3 <i>N</i> HCl	2	15	-246.6	
C ₁₉ H ₂₂ N ₂ O ₂ .2H ₂ O	Apoquinidine.....	97% EtOH	2	15	155.3	(875)
		3 <i>N</i> HCl	2	15	216.5	
C ₁₉ H ₂₂ N ₂ O	Apoquinamine.....	EtOH	2	15	0	(877); cf. (934)
		11 <i>N</i> HCl	2	15	-30.0	
C ₁₉ H ₂₄ N ₂ O ₂	Quinamine.....	EtOH	1.774	15	100.7	(1541); cf. (865,
		Et ₂ O	1.024	15	119.9	871.5,
		CHCl ₃	2.235	15	93.3	877)
		C ₆ H ₆	1.489	15	100.9	(877)
C ₁₉ H ₂₄ N ₂ O ₂	Quinamidine.....	97% EtOH	2	15	4.5	(877)
		97% EtOH	2	15	38.1	
C ₁₉ H ₂₄ N ₂ O ₂	Conquinamine.....	EtOH	4.018	15	204.1	(1542, 1543); cf. (878)
		Et ₂ O	1.522	15	188.1	
		CHCl ₃	2	15	184.5	(878)
		3 <i>N</i> HCl	4	15	230.0	

Quinine and isomerides ($C_{20}H_{24}N_2O_2$) and their derivatives.—(Continued)

Formula	Name	Solvent	d, C or %	$t, ^\circ C$	$[\alpha]_D$	Lit.
$C_{19}H_{25}ClN_2O_2 \cdot H_2O$	Quinamine hydrochloride.....	H_2O	2	15	100.0	(877)
$C_{19}H_{25}BrN_2O_2 \cdot H_2O$	Quinamine hydrobromide.....	H_2O	4	15	88.2	
$C_{19}H_{25}IN_2O_2$	Quinamine hydroiodide.....	EtOH	2.310	16	95.8	(1541)
$C_{20}H_{22}N_2O_2$	Dehydroquinine.....	$CHCl_3$.EtOH	2.1	17	-179	(290)
$C_{20}H_{22}N_2O_2$	Quininone.....	EtOH	2.14	23	73.79*	(1755)
$C_{20}H_{23}Br_3N_2O$	Quinine tribromide (a) isomeride.....	MeOH		10	198	(620)
	(b) isomeride.....	$CHCl_3$		10	119	
$C_{20}H_{23}ClN_2O$	Quinine chloride.....	EtOH	1.90	15	61	(1756)
$C_{20}H_{23}ClN_2O$	Quinidine chloride.....	EtOH	1.943	15	35.25	
$C_{20}H_{23}ClN_2O_2$	Quininone hydrochloride.....	EtOH	1.93	14	58.67	(1755)
$C_{20}H_{24}N_2O$	Desoxyquinine, anhydrous.....	EtOH	2.252	20	-97.7	(1756)
	Hydrated.....	EtOH	2.021	15	-93.0	(1756)
$C_{20}H_{24}N_2O \cdot H_2O$	Desoxyquinidine, anhydrous.....	EtOH	2.023	20	211.1	(1756)
	Hydrated.....	EtOH	2.254	15	191.9	
$C_{20}H_{24}N_2O_2$	Quinine.....	C_6H_6	0.61	17	-136	(1196); cf. (1945)
		PhMe	0.39	17	-127	
		$CHCl_3$	1.465	17	-117	
		EtOH	2.136	15	-158.2	(1756)
$C_{20}H_{24}N_2O_2$	α -Isoquinine.....	EtOH	1.0	18	-245	(163)
		EtOH	0.5	18	-248	
	β -Isoquinine.....	EtOH	0.5	18	-192.4	
		EtOH	1.0	18	-195.35	
		EtOH	2.0	18	-191.6	
$C_{20}H_{24}N_2O_2$	Quinidine (conquinine); cf. (867, 885.5, 1196, 2223).....	C_6H_6	1.62	17	195.2	(1540)
		PhMe	1.62	17	206.2	(1612); cf.
		$CHCl_3$	1.62	17	228.8	(885.5,
		97% EtOH	1.0		233.6	1540)
		90% EtOH	0.7735	15	243.5	
$C_{20}H_{24}N_2O_2$	Quinicine.....	$CHCl_3$	2	15	44.1	(866)
		$CHCl_3$			38.67	(934)
$C_{20}H_{24}N_2O_2$	Quinine isomeride.....	EtOH	0.9248		-237.89	(162)
		EtOH	0.9702		-181.67	
$C_{20}H_{24}N_2O_2$	Isoconquinine.....	97% EtOH	1.394		-9	(1612)
$C_{20}H_{24}N_2O_5S$	Quininesulfonic acid.....	3N HCl	2	15	-182.2	(888.5)
$C_{20}H_{25}ClN_2O_2$	Quinine hydrochloride.....	H_2O	1.54	17	-133.7	(1540)
		H_2O	1	15	-227.25	
		H_2O	3.97	21.8	-228.0	(1445)
		H_2O	3.82	85.1	-216.7	
		EtOH	1.54*	17	-138.0	
		1N HCl	7	15	-213.99	(885.5)
$C_{20}H_{25}ClN_2O_2 \cdot H_2O$	Quinidine hydrochloride.....	H_2O	2	15	195.97	(885.5); cf. (1540)
$C_{20}H_{26}N_3O_6 \cdot H_2O$	Quinidine nitrate.....	EtOH	2.17	17	232	(1540)
$C_{20}H_{26}Cl_2N_2O_2 \cdot H_2O$	Quinidine dihydrochloride.....	H_2O	2	15	250.3	(885.5)
$C_{20}H_{26}N_2O_2$	Hydroquinine.....	EtOH	2.4	20	-142.2	(1196); cf. (880.5, 886)
$C_{20}H_{26}N_2O_6S$	Quinine hydrogen sulfate.....	H_2O	4.22	15.9	-212.2	(1445)
		H_2O	4.09	7.85	-189.9	
$C_{20}H_{26}N_2O_6S \cdot 7H_2O$	Hydrated.....	80% EtOH	1	15	-154.5	(885.5)
		80% EtOH	3	15	-153.3	
$C_{21}H_{24}N_2O_4$	Acetylquininol.....	$CHCl_3$	1	22	-63.5	(1917)
$C_{21}H_{26}N_2O_4$	Quinine formate.....	H_2O	2.00	21	-141.1	(1145); cf. (1146)
$C_{22}H_{26}N_2O_3$	Acetylquinine.....	3N HCl	2	22.9	-120.8	(1917); cf.
		$CHCl_3$	1	14.4	-30.9	(881.5)
$C_{22}H_{26}N_2O_3$	Acetylquinidine.....	97% EtOH	2	15	127.6	(875)
		3N HCl	2	15	216.5	
$C_{23}H_{26}N_2O_4$	Diacetylpoquinine.....	3N HCl	2	15	-107.5	(875)
		EtOH	2		-61.8	

* Calculated on weight of alkaloid.

Quinine and isomerides (C₂₀H₂₄N₂O₂) and their derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₂₃ H ₂₆ N ₂ O ₄	Diacetylapoquinidine.....	97% EtOH	2	15	40.4	(875)
		3 <i>N</i> HCl	2	15	78.4	
C ₂₃ H ₂₈ N ₂ O ₃	Propionylquinine.....	3 <i>N</i> HCl	2	15	108.8	(875)
C ₂₆ H ₂₆ N ₂ O ₄	Benzoylquininal.....	CHCl ₃	1	22.4	79.4	(1917)
C ₂₇ H ₂₈ N ₂ O ₃	Benzoylquinine.....	EtOH	1	19.2	119.9	(1917)
		CHCl ₃	1	16.6	118.1	
C ₃₉ H ₄₆ N ₄ O ₄	Cupreinequinine (homoquinine).....	EtOH	5		−158	(935)
C ₃₀ H ₃₈ N ₂ O ₆ S	Quinine <i>dl</i> - <i>sec</i> -butylbenzenesulfonate.....	MeOH	1.24	20	−10.5	(1088)
C ₄₀ H ₆₀ N ₄ O ₈ S	Quinine sulfate; <i>cf.</i> (268, 875, 885.5, 1540, 1543).....	80% EtOH	2	15	−162.95	(396)
		60% EtOH	2	15	−166.36	
		1.249 <i>N</i> H ₂ SO ₄	3	19	−237.7	(1658)
	Heptahydrate.....	1.249 <i>N</i> H ₂ SO ₄			−203.3	(1658)
	Quinidine sulfate heptahydrate.....	H ₂ O	1.0		179.5	(1612); <i>cf.</i> (885.5, 1540)
	Isoconquinine hydrogen sulfate.....	H ₂ O	2.464		10.2	(1612)
	Quinidine hydrogen sulfate dihydrate.....	H ₂ O	2.0		210.5	(1612); <i>cf.</i> (885.5, 1540)
	Isoconquinine sulfate.....	H ₂ O	1.406		−35.5	(1612)
C ₄₀ H ₅₂ N ₄ O ₈ ·H ₂ O	Nitrocamphorquinine.....	EtOH	2.72		45.9	(276)
C ₄₂ H ₆₀ N ₄ O ₈ ·3H ₂ O	Quinine oxalate.....	EtOH	1.54*	17	−131.4	(885.5)
C ₄₂ H ₆₀ N ₄ O ₈	Quinicine oxalate.....	H ₂ O	2		10	(1613)
C ₄₂ H ₆₀ N ₄ O ₈ ·9H ₂ O	Hydrated.....	H ₂ O	2	15	9.54	(866)
		2 <i>M</i> H ₂ SO ₄	2	15	15.54	(866)
C ₄₂ H ₆₀ N ₄ O ₈	Isoquinicine oxalate.....	H ₂ O	2		−8.59	(1613)
		H ₂ O	2		−9.79	
<i>Strychnine, its isomerides and derivatives</i>						
C ₁₉ H ₁₈ N ₂ O ₃	Strychninolone.....	AcOH	2.66	20	−112.4	(1214)
C ₂₁ H ₂₀ N ₂ O ₆	Strychninonic acid.....	0.1 <i>N</i> NaOH	7.874	20	−43.3	(1204)
C ₂₁ H ₂₁ N ₃ O ₆	Strychninonic acid oxime.....	0.1 <i>N</i> NaOH	3.91	20	119	(1214)
C ₂₁ H ₂₂ N ₂ O ₂	Strychnine; <i>cf.</i> (920, 1945, 1946, 1995, 2053, 2223).....	CHCl ₃	4		−130	(1539)
		CHCl ₃	2.5		−137.7	
		CHCl ₃	1.5		−140.7	
		EtOH	0.91		−128	
	Isostrychnine.....	EtOH	3.4	17.5	6.77	(1533); <i>cf.</i> (1640)
C ₂₁ H ₂₂ N ₂ O ₃	Strychnine oxide.....	H ₂ O	1.86		−1.75	(1644)
C ₂₁ H ₂₂ N ₂ O ₆ ·2H ₂ O	Strychninesulfonic acid.....	0.1 <i>N</i> NaOH	2.02	20	−138	(1215)
C ₂₁ H ₂₂ N ₂ O ₆ ·3H ₂ O	Strychninesulfonic acid.....	0.1 <i>N</i> NaOH	2.02	20	−163.3	(1215)
C ₂₁ H ₂₂ N ₂ O ₆	Dihydrostrychninonic acid.....	0.1 <i>N</i> NaOH	3.5	20	4.3	(1204)
C ₂₁ H ₂₄ N ₂ O ₆ ·2H ₂ O	Strychninesulfonic acid, IV hydrate.....	H ₂ O	2.010	20	18.3	(1217)
C ₃₁ H ₃₆ N ₂ O ₆ S	Strychnine <i>dl</i> - <i>sec</i> -butylbenzenesulfonate....	MeOH	0.846	20	0	(1088)
C ₆₁ H ₆₂ N ₂ O ₁₀ S ₂ Si ₂	Strychnine dibenzylpropylethylsilicanedisulfonate (Si ₂ C ₂ H ₅ C ₃ H ₈ (CH ₂ C ₆ H ₄ SO ₂ −OH) ₂ C ₂₁ H ₂₂ N ₂ O ₂).....	98% MeOH	2.465		−15.21	(281)
		64% MeOH	2.119		−22.4	(281)
<i>Brucine (C₂₃H₂₆N₂O₄) and its derivatives</i>						
C ₂₁ H ₂₂ N ₂ O ₆	Brucinolone.....	AcOH	4.78	22	−34.7	(1367); <i>cf.</i>
		AcOH	2.38	22	−32.6	(1207,
		AcOH	4.56	22	−37.2	1213,
		AcOH	3.93	22	−37.7	1216)
C ₂₁ H ₂₂ N ₂ O ₅	Isobrucinolone.....	AcOH	1.1	24	26.7	(1207)
C ₂₃ H ₂₂ N ₂ O ₈ Na ₂	Sodium brucinonate.....	H ₂ O	4.27*	20	−48.5	(1204)
C ₂₃ H ₂₄ N ₂ O ₇	Trihydroxydehydrobrucine.....	37.6% HCl	3.73	20	87.4	(1212)
C ₂₃ H ₂₄ N ₂ O ₈ Na ₂	Sodium dihydrobrucinonate.....	H ₂ O	16.1*	20	−14.8	(1204)
C ₂₃ H ₂₆ N ₃ O ₈	Brucinonic acid oxime.....	AcOH	2.68	17	81.7	(1209)
		0.1 <i>N</i> NaOH	4.71	20	128.2	(1216)
C ₂₃ H ₂₆ N ₂ O ₄	Brucine.....	EtOH	5.4		−85	(1539); <i>cf.</i>
		CHCl ₃	4.9		−119	(2053)
		CHCl ₃	1.9		−127	

* Calculated on weight of alkaloid.

Brucine (C₂₃H₂₆N₂O₄) and its derivatives.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₂₃ H ₂₆ N ₂ O ₄	Allobrucine.....	CHCl ₃	4.54		−112.8	(1464)
C ₂₃ H ₂₆ N ₂ O ₅	Brucine oxide.....	H ₂ O	3.05	28	−1.63	(1643)
C ₂₃ H ₂₆ N ₂ O ₇	Trioxybrucine.....	AcOH	4.33	20	5.66	(1212)
C ₂₃ H ₂₆ N ₂ O ₇ S	Brucine sulfonic acid I.....	0.1 <i>N</i> NaOH	4.48	20	−242	(1211)
	II.....	0.1 <i>N</i> NaOH	2.3	20	29.2	
	III.....	0.1 <i>N</i> NaOH	2.36	20	156.8	
C ₂₃ H ₂₆ N ₂ O ₈	Brucinolic acid.....	0.1 <i>N</i> NaOH	4.56	20	−22	(1216)
C ₂₃ H ₂₇ ClN ₂ O ₆	Brucine hydrochloride.....	H ₂ O	0.595	28	−13.95	(1643)
C ₂₃ H ₂₇ N ₃ O ₈	Brucine nitrate.....	H ₂ O	0.879	30	−11.36	(1643)
C ₂₄ H ₂₇ N ₅ O ₈ ·3H ₂ O	Brucinonic acid semicarbazone.....	0.1 <i>N</i> NaOH	5.13	20	252	(1216)
C ₂₅ H ₂₈ N ₂ O ₉	Diacetyldihydroxydihydrobrucinoline- <i>b</i>	AcOH	1.95	20	−149.2	(1210)
C ₂₆ H ₃₄ N ₂ O ₇	Methylbrucine acetate.....	H ₂ O	4.01	20	−9.97	(1465)
C ₂₇ H ₂₈ N ₂ O ₈	Brucine hydrogen acetylenedicarboxylate...	CHCl ₃	0.47	27	−5.26	(903)
		EtOH	0.47	27	−3.22	
		H ₂ O	3.73	25	−15.02	
		H ₂ O	0.93	25	−18.77	
C ₂₇ H ₃₀ N ₂ O ₈	Brucine hydrogen fumarate.....	EtOH	0.47	23	10.69	(903)
		H ₂ O	1.870	24	−24.86	
		H ₂ O	0.94	24	−25.14	
C ₂₇ H ₃₀ N ₂ O ₈	Brucine hydrogen maleate.....	CHCl ₃	0.49	25	6.12	(903)
		H ₂ O	0.98	25	−24.49	
C ₂₇ H ₃₂ N ₂ O ₈	Brucine hydrogen succinate.....	CHCl ₃	0.47	25	−23.40	(903)
		EtOH	0.47	25	−31.92	
		H ₂ O	3.74	24	−27.81	
		H ₂ O	0.94	24	−24.60	
C ₂₇ H ₃₆ N ₂ O ₇	Dimethylbrucine acetate.....	H ₂ O	4.2	20	−7.14	(1465)
C ₂₈ H ₂₆ N ₂ O ₆	Benzoylisobrucinolone.....	AcOH	2.00	16	99	(1210)
C ₂₈ H ₂₆ N ₂ O ₆	Benzoylbrucinolone- <i>b</i>	AcOH	2.93	16	−148	(1210)
C ₂₉ H ₃₂ N ₂ O ₆ S	Brucine benzenesulfinate.....	CHCl ₃	5	22	−19.8	(903)
C ₂₉ H ₃₂ N ₂ O ₇ S	Brucine benzenesulfonate.....	CHCl ₃	5	22	−16.1	
C ₂₉ H ₃₆ N ₂ O ₁₀	Brucine anhydrotalonate.....	EtOH	2.5	20	−12.45	(1221)
C ₂₉ H ₃₆ N ₂ O ₁₀	Brucine anhydrogalactonate.....	EtOH	2.5	20	−9.23	(1221)
C ₂₉ H ₃₆ N ₂ O ₁₀	Brucine lyxohexosamate (deaminized).....	EtOH	2.5	25	−11.96	(1221)
C ₃₀ H ₃₂ N ₂ O ₆	Brucine benzoate.....	CHCl ₃	5	21	−25.4	(902)
		CHCl ₃	2.5	21	−25.0	
C ₃₀ H ₃₂ N ₂ O ₇	Brucine salicylate.....	CHCl ₃	5	21	14.2	(902)
C ₃₀ H ₃₃ N ₃ O ₆	Brucine anthranilate.....	CHCl ₃	5	21	−9.0	(902)
C ₃₀ H ₃₄ N ₂ O ₆ S	Brucine <i>p</i> -toluenesulfinate.....	CHCl ₃	5	21	−15.2	(903)
C ₃₀ H ₃₄ N ₂ O ₇ S	Brucine <i>p</i> -toluenesulfonate.....	CHCl ₃	5	21	−12.5	
C ₃₁ H ₃₄ N ₂ O ₆	Brucine phenylacetate.....	CHCl ₃	5	21	−30.5	(902)
		CHCl ₃	2.5	21	−32.2	
C ₃₁ H ₃₆ N ₂ O ₆ S	Brucine <i>p</i> -xylene-2-sulfinate.....	CHCl ₃	5	21	−14.0	(903)
C ₃₁ H ₃₆ N ₂ O ₇ S	Brucine <i>p</i> -xylene-2-sulfonate.....	CHCl ₃	5	21	−15.5	
C ₃₁ H ₃₆ N ₂ O ₇ S	Brucine phenetylsulfinate.....	CHCl ₃		22	−20.3	(903)
C ₃₁ H ₃₆ N ₂ O ₈ S	Brucine phenetylsulfonate.....	CHCl ₃		22	−14.1	(903)
C ₃₂ H ₃₂ N ₂ O ₃	Brucine phenylpropiolate.....	CHCl ₃	3.75		3.33	(901)
		CHCl ₃	0.94		2.67	
		H ₂ O	0.94		−22.94	
		CHCl ₃	3.64	18	−11.68	(901)
C ₃₂ H ₃₄ N ₂ O ₄	Brucine cinnamate.....	CHCl ₃	0.91	18	−17.58	
		CHCl ₃	0.91		−18.68	
		CHCl ₃	5	21	15.1	(902)
C ₃₂ H ₃₄ N ₂ O ₈	Brucine acetylsalicylate.....	CHCl ₃	5	21	5.2	(902)
C ₃₂ H ₃₅ N ₃ O ₇	Brucine acetylanthranilate.....	CHCl ₃	5	21	−38.2	(902)
C ₃₂ H ₃₆ N ₂ O ₆	Brucine β-phenylpropionate.....	CHCl ₃	5	21	−38.5	
		CHCl ₃	2.5	21	−38.5	
		CHCl ₃	3.64	19	−38.19	(901)
		CHCl ₃	0.91	19	−38.46	
		H ₂ O	0.91	19	−25.27	
C ₃₂ H ₄₀ N ₂ O ₆	Brucine 1-methylcyclohexylidene acetate, <i>see</i> p. 458					
C ₃₇ H ₃₆ N ₂ O ₈	Brucine benzoylsalicylate.....	CHCl ₃	5	21	±0.1	(902)
C ₃₇ H ₃₇ N ₃ O ₇	Brucine benzoylanthranilate.....	CHCl ₃	5	21	24.6	(902)
C ₅₀ H ₆₆ N ₄ O ₁₂	Brucine fumarate.....	CHCl ₃	1.79	24	−61.45	(903)
		H ₂ O	1.79	22	−34.91	

Brucine (C₂₃H₂₆N₂O₄) and its derivatives.—(Continued)

Formula	Name	Solvent	d, C or %	t, °C	[α] _D	Lit.
C ₅₀ H ₅₆ N ₄ O ₁₂	Brueine maleate.....	CHCl ₃	1.74	24	−63.22	(903)
		CHCl ₃	0.87	24	−61.51	
		H ₂ O	3.48	23	−44.97	
		H ₂ O	0.87	23	−41.96	
C ₅₀ H ₅₈ N ₄ O ₁₂	Brueine succinate.....	CHCl ₃	4	25	−68.75	(903)
		CHCl ₃	1	25	−75.50	
		H ₂ O	4	25	−33.75	
Other alkaloids, their derivatives and other substances						
C ₈ H ₁₆ N	α-Conieicine.....	EtOH	1.66	15	18.4	(1266)
C ₉ H ₁₁ BrN ₂ O ₆	Bromouridine.....	H ₂ O	10.05	21	−15.4	(1231)
C ₉ H ₁₃ N ₃ O ₅	Cytidine.....	H ₂ O	10.0	21	29.6	(1231)
C ₉ H ₁₄ N ₂ O	α-Oximino-β-vinylquinuelidine.....	EtOH	2.005	16	113	(1756)
C ₉ H ₁₄ N ₂ O ₆	Dihydrouridine.....	H ₂ O	4.028		39.1	(1231)
C ₉ H ₁₅ N ₅ O ₆	Carnosine nitrate.....	H ₂ O	7.60	19.5	22.2	(764)
C ₁₀ H ₁₃ NO ₃	Ratanhine.....	11% HCl	2.013	19	−18.6	(732)
C ₁₁ H ₁₄ N ₂ O	Cytisine.....	H ₂ O	2	12	−120	(1655)
		CHCl ₃	2	12	−100.42	
		90% EtOH	2	12	−100.42	(1768)
		CHCl ₃	2	12	−65.42	
C ₁₁ H ₁₅ N ₃ O ₄	Cytisine nitrate.....	H ₂ O	5	11	−90.17	(1655)
C ₁₁ H ₁₈ N ₂	Daueine.....	Et ₂ O			7.74	(1641, 1642)
C ₁₁ H ₂₀ Cl ₂ N ₂	Tetrahydrodesoxyeytisine dihydrochloride..	H ₂ O	8		−10.25	(672)
		H ₂ O	1.128		−2.22	(1710)
C ₁₂ H ₁₆ N ₂ O	Methylcytisine.....	H ₂ O	2	18.5	−224.7	(1768)
		H ₂ O	50	18.5	−219.7	
		EtOH	5	18.5	−170.2	
		EtOH	30	18.5	−154.9	
		CHCl ₃	5	19.5	−163.33	
		CHCl ₃	40	19.5	−141.6	
		MeOH	5		−198	
		MeOH	40		−164.4	
C ₁₃ H ₁₈ N ₂ O	Eseroline.....	MeOH	1.368		−107.2	(1856)
C ₁₅ H ₁₅ BrO ₆	α-Bromopierotoxinin.....	CHCl ₃	0.9520	17	−69.9	(926)
		CHCl ₃	0.9608	17	−129.1	
C ₁₅ H ₁₆ O ₆	Pierotoxinin.....	EtOH	4.279	17	4.40	(926); cf.
		Me ₂ CO	8.131	17	4.5	(1948)
		Prepd. from α-bromopierotoxinin.....	Me ₂ CO	7.576	17	3.49
C ₁₅ H ₁₇ NO ₃	Benzoyl-d-orseine.....	50% EtOH	1.17		3.5	(2048)
C ₁₅ H ₁₈ O ₇	Pierotin.....	EtOH	2.07	16	−69.64	(1948)
C ₁₅ H ₂₁ N ₃ O ₂	Physostigmine (from Calabar beans).....	CHCl ₃	1.329		−75.8	(1855)
		Commercial.....	CHCl ₃	1.531		−75.8
C ₁₅ H ₂₆ N ₂	Lupinidine.....		1.023	20	−5.96	(2188)
		99% EtOH	14.20	21	−16.41	
C ₁₆ H ₁₇ NO ₄	Narcissine (from <i>Narcissus pseudonarcissus</i>)	EtOH	0.166	10	−95.8	(439)
C ₁₆ H ₁₈ N ₂ O ₃	Carpiline.....	EtOH	1.014	20	24.0	(1191)
C ₁₆ H ₁₉ ClN ₂ O ₃	Carpiline hydrochloride.....	EtOH	1.212	22	15.4	(1191)
C ₁₆ H ₂₄ O ₄	Bufotalin.....	CHCl ₃	6.8	20	5.4	(2176)
C ₁₆ H ₂₇ IN ₂ O	d-Lupanine methiodide.....	H ₂ O	3.819	18	51.48	(99)
		H ₂ O	5.633	19	51.35	
C ₁₇ H ₁₇ NO ₃	Pukateine.....	EtOH	0.6	15	−220	(63)
C ₁₇ H ₁₉ NO ₃	Isobebeerine.....	Py	4.24	20	68.4	(1889)
C ₁₇ H ₂₁ NO ₄	Seopolamine; cf. (697, 891, 2181, 2182).....	EtOH	2.65	15	−13.7	(891)
		H ₂ O			−14.97	(224.3)
C ₁₇ H ₂₂ BrNO ₄	Seopolamine anhydride hydrobromide.....	H ₂ O	4.5	18	−26.0	(2186)
C ₁₇ H ₂₄ N ₂ O ₅	Casimeroedine.....	1% HCl	2.099		−36.5	(1695)
C ₁₈ H ₁₉ NO ₃	Oxyeanthine.....	EtOH.CHCl ₃	4	15	131.6	(884, 891)
C ₁₈ H ₂₀ ClNO ₃ .2H ₂ O	Hydrochloride.....	H ₂ O	2	15	163.6	(884, 891)
C ₁₈ H ₂₁ NO ₃	Bebeerine.....	EtOH	1.6	25	297	(1886)
C ₁₈ H ₂₁ NO ₄	Chondrodine.....	EtOH	1.0	20	−75	(1888)
C ₁₉ H ₁₉ NO ₄	Bulbocapnine.....	CHCl ₃	4.48	16	237.1	(673)
C ₁₉ H ₂₂ N ₂ O ₂ .2H ₂ O	Cupreine.....	EtOH	1.78	17	−173.3	(1545)
C ₁₉ H ₂₃ ClN ₂ O ₂	Cupreine hydrochloride.....	EtOH	1.42	17	−167.3	(1545)
		H ₂ O	0.871	17	−154.8	

Other alkaloids, their derivatives and other substances.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	[α] _D	Lit.
C ₁₉ H ₂₄ Cl ₂ N ₂ O ₂ ·2H ₂ O	Cupreine dihydrochloride.....	H ₂ O	17.28	17	−191.1	(1545)
		H ₂ O	1.19	17	−211.0	
C ₂₀ H ₂₁ NO ₄	<i>d</i> -Bulboeapnine methyl ether.....	CHCl ₃	1.570	20	247.2	(705)
	<i>l</i> -Bulboeapnine methyl ether.....	CHCl ₃	1.728	20	−246.5	
C ₂₀ H ₂₂ INO ₄	Bulboeapnine.....	EtOH	1.4936	20	173.8	(705)
C ₂₀ H ₂₂ N ₂ O ₂	Gelsemine.....	CHCl ₃	2.033		15.9	(1452); <i>cf.</i> (1455)
C ₂₀ H ₂₃ ClN ₂ O ₂	Hydrochloride.....	H ₂ O	1.550		2.6	(1452, 1455)
C ₂₀ H ₂₂ N ₂ O ₂	Gelsemine, isomeride of.....	CHCl ₃	0.596		25.2	(1455)
C ₂₀ H ₂₃ ClN ₂ O ₂	Chloroisoapogelsemine.....	CHCl ₃	1.224		74.2	(1455)
C ₂₀ H ₂₃ NO ₄	Corypalmine.....	CHCl ₃	0.38	16	280	(1977)
C ₂₀ H ₂₃ N ₃ O ₂	Pheneserine.....	EtOH			−80	(1659)
C ₂₀ H ₂₃ N ₃ O ₃	Phenogeneserine.....	CHCl ₃			−125.5	(1659)
C ₂₀ H ₂₄ N ₂ O ₃	Isoapogelsemine.....	Py	2.406		16.6	(1455)
C ₂₀ H ₂₅ ClN ₂ O ₃ ·H ₂ O	Hydrochloride.....	H ₂ O	1.045		27.1	(1455)
	Apogelsemine hydrochloride.....	H ₂ O	2.071		18.9	
C ₂₁ H ₁₈ N ₂	<i>l</i> -Isoamarine.....	EtOH	1.49		−28.94*	(1972)
C ₂₁ H ₂₁ NO ₅	Corycavamine.....	CHCl ₃	2.23	20	166.6	(700)
C ₂₁ H ₂₃ NO ₄	<i>d</i> -Corydine.....	CHCl ₃	1.592	20	206.2	(702)
C ₂₁ H ₂₃ NO ₄	Isoecorydine.....	CHCl ₃	1.60	20	195.3	(702)
C ₂₁ H ₂₃ NO ₄	β-Bebirine.....	Py	1.70	21	−24.7	(441)
		EtOH	1.64	21	28.6	
	Isobebirine.....	Py	1.73	22	−47.7	
C ₂₁ H ₂₄ INO ₄	Bulboeapnine methyl ether methiodide.....	EtOH	1.48	20	163.7	(705)
C ₂₁ H ₂₅ IN ₂ O ₂	Gelsemine methiodide.....	H ₂ O	1.025		8.9	(1455)
C ₂₁ H ₂₅ NO ₄	Corybulbine.....	CHCl ₃	1.41	20	303.3	(704)
C ₂₁ H ₂₅ NO ₄	Isocorybulbine.....	CHCl ₃	1.045	20	299.8	(700)
C ₂₁ H ₂₅ NO ₄	<i>d</i> -Tetrahydropalmatine.....	EtOH	1.93	17	292.5	(1977)
C ₂₁ H ₂₆ IN ₃ O ₂	Pheneserine methiodide.....	EtOH			−92.8	(1659)
C ₂₃ H ₂₃ NO ₁₀	Hydrastine acid oxalate.....	CHCl ₃	2.0		8.22	
C ₄₂ H ₄₄ N ₂ O ₁₆ S	Hydrastine sulfate.....	CHCl ₃	2.0		7.44	(268)
C ₂₁ H ₂₆ N ₂ O ₂	Cupreine ethyl ester.....	EtOH			−169.4	(749)
C ₂₁ H ₂₆ N ₂ O ₃	Yohimbine (quebrachine).....	EtOH	2	15	62.5	(879)
		97% CHCl ₃	2	15	18.6	
C ₂₁ H ₂₇ IN ₂ O ₃	Apogelsemine methiodide.....	H ₂ O	1.335		12.4	(1455)
	Isoapogelsemine methiodide.....	H ₂ O	1.630		28.1	
C ₂₂ H ₂₃ NO ₇	Narcotine.....	EtOH	0.74	22.5	−185.0	(1799)
		97% CHCl ₃	2.5	22.5	−207.35	
		C ₆ H ₆	1.59		−229	(885.5)
C ₂₂ H ₂₄ N ₂ O ₃	Acetylgelsemine.....	CHCl ₃	1.745		23.9	(1455)
C ₂₂ H ₂₅ ClN ₂ O ₃	Chloroacetylisoapogelsemine.....	CHCl ₃	1.020		142.9	(1455)
C ₂₂ H ₂₆ ClNO ₄	<i>d</i> -β-Canadine ethylechloride.....	50% EtOH	0.91	20	138.5	(2080)
C ₂₂ H ₂₆ ClNO ₄ ·2H ₂ O	<i>l</i> -α-Canadine ethylechloride.....	50% EtOH	0.75	20	−127.3	(2080)
C ₂₂ H ₂₆ INO ₄	<i>d</i> -β-Canadine ethiodide.....	50% EtOH	1.01	20	115	(2080)
C ₂₂ H ₂₆ INO ₄ ·1.5H ₂ O	<i>l</i> -α-Canadine ethiodide.....	50% EtOH	1.00	20	−92.2	(2080)
C ₂₂ H ₂₆ N ₂ O ₇	<i>d</i> -β-Canadine ethylnitrate.....	50% EtOH	0.99	20	130.7	(2080)
C ₂₂ H ₂₆ N ₂ O ₇ ·1.5H ₂ O	<i>l</i> -α-Canadine ethylnitrate.....	50% EtOH	1.00	20	−121	(2080)
C ₂₂ H ₂₇ NO ₄	Corydaline.....	CHCl ₃	6.55	16	300.1	(673)
C ₂₂ H ₂₈ ClNO ₄	Dimethylcorytuberine methochloride.....	H ₂ O	1.0104		197.40	(702)
C ₂₂ H ₂₈ N ₂ O ₂	Aspidospermatine.....	97% EtOH	2	15	−72.3	(879)
C ₂₂ H ₂₈ N ₂ O ₄ ·H ₂ O	Echitamine.....	97% EtOH	2	15	−28.8	(873); <i>cf.</i> (830)
C ₂₂ H ₃₀ N ₂ O ₂	Aspidospermine.....	97% EtOH	2	15	−100.2	(879)
		CHCl ₃	2	15	−83.6	
		3 <i>N</i> HCl	2	15	−61.6	
		10 <i>N</i> HCl	2	15	−62.2	
C ₂₂ H ₃₁ NO ₂	Atisine.....	EtOH			−19.6	(1012)
C ₂₂ H ₃₂ ClNO ₂	Atisine hydrochloride.....	H ₂ O			18.46	
C ₂₂ H ₃₂ BrNO ₂	Atisine hydrobromide.....	H ₂ O			24.3	
C ₂₂ H ₃₂ INO ₂	Atisine hydroiodide.....	H ₂ O			27.4	

* Mutarotation.

Other alkaloids, their derivatives and other substances.—(Continued)

Formula	Name	Solvent	<i>d</i> , <i>C</i> or %	<i>t</i> , °C	$[\alpha]_D$	Lit.
$C_{23}H_{26}N_2O_4 \cdot 2H_2O$	Cusconine.....	Et ₂ O	2	15	−26.8	(868, 881)
		EtOH	2	15	−54.3	
		3 <i>N</i> HCl	0.5	15	−71.8	
	Concusionine.....	EtOH	2	15	36.8	(881); <i>cf.</i> (882)
$C_{23}H_{26}N_2O_4$	Acrine.....	Et ₂ O	1	15	−94.7	(868)
		EtOH	1	15	−54.1	(868)
$C_{23}H_{29}NO_9$	Oxonitine.....	CHCl ₃	0.508	16	−62	(266)
$C_{24}H_{28}ClN_3O$	Quaternary isocalycanthine chloride.....	H ₂ O	0.541	24	246.8	(738)
$C_{24}H_{28}IN_3O$	Quaternary isocalycanthine iodide.....	EtOH	0.3264	23.5	189.9	(738)
$C_{24}H_{29}NO_7$	α-Triacetylhydroxyisoberberine.....	Py	1.544	20	68.1	(1890)
$C_{24}H_{35}ClNO_9$	Pyroaconine hydrochloride.....	H ₂ O	1.96	15	−102.07	(400)
$C_{24}H_{29}ClN_2O_5$	Diacetylalogelsemine hydrochloride.....	H ₂ O	1.075		21.7	(1455)
	Diacetylisoalogelsemine hydrochloride.....	H ₂ O	1.152		24.6	
$C_{25}H_{30}Cl_2N_2O$	Phenyleinchotol dihydrochloride.....	H ₂ O	0.474	15	21.09	(351)
$C_{25}H_{32}BrNO_7S$	Benzoyl- <i>d</i> -oscine <i>d</i> -bromocamphorsulfonate.	H ₂ O	2.046		52.1	(2048)
$C_{25}H_{33}NO_7S$	Benzoyloscine <i>d</i> -camphorsulfonate.....	H ₂ O	2.113		10.3	(2048)
$C_{25}H_{40}O_{10}$	Lepranthin.....	CHCl ₃		17	71	(2243)
$C_{25}H_{41}NO_7$	Bikhaconine.....	EtOH	2.44	22	33.85	(399)
$C_{25}H_{41}NO_8$	Indaconine.....	H ₂ O	1.82	22	38.20	(399)
		EtOH	2.8	22	38.18	
$C_{25}H_{41}NO_9$	Aconine.....	H ₂ O			23.0	(268)
$C_{26}H_{41}NO_{11}$	Aconine.....	H ₂ O	3.534	15	23	(403)
$C_{26}H_{42}ClNO_{11}$	Aconine hydrochloride.....	H ₂ O	5.75	15	−771	(401); <i>cf.</i> (400.5)
$C_{26}H_{42}N_2O_{10} \cdot 2H_2O$	Bikhaconine nitrate.....	H ₂ O	2.03	20	15.38	(399)
$C_{26}H_{23}NO_5$	Monobenzoylbulbocapnine.....	CHCl ₃	1.572	20	92.7	(705)
$C_{26}H_{25}NO_5$	Monobenzoylerytuberine.....	CHCl ₃	0.9916	20	151.5	(702)
$C_{26}H_{28}N_2O_2$	Hydrocinchonine.....	EtOH abs.	6.17	23	8.8	(1045)
$C_{27}H_{26}INO_5$	Monobenzoylbulbocapnine methiodide.....	CHCl ₃	1.6	20	28.1	(705)
$C_{27}H_{28}N_4O_3$	Dipheneserine.....	CHCl ₃			−244	(1659)
$C_{28}H_{28}N_2O_6$	Acetyltrimethylbrasilin.....	AcOH	1.00	20	128.23	(863)
$C_{29}H_{36}N_2O_4$	Emetamine.....	CHCl ₃	6.14		11.2	(1752)
		CHCl ₃	4.28		9.9	
		EtOH	2.11		12.3	
		H ₂ O	8.04		−24.3	(1752)
$C_{29}H_{38}Br_2N_2O_4 \cdot 7H_2O$	Dihydrobromide.....	H ₂ O	4.16		−22	
		H ₂ O				
$C_{29}H_{38}N_2O_4$	<i>o</i> -Methylpsychotrine.....	EtOH	3.88		43.9	(1752)
		EtOH	2.08		46.1	
$C_{29}H_{40}N_2O_8S \cdot 7H_2O$	Sulfate.....	H ₂ O	8.06		44.4	(1752)
$C_{29}H_{40}N_2O_8S \cdot H_2O$		H ₂ O	4.19		52.7	(1752)
$C_{29}H_{40}Br_2N_2O_4$	Dihydrobromide.....	H ₂ O	1.65		48.0	(1752)
$C_{31}H_{40}N_2O_8 \cdot 3.5H_2O$	Oxalate.....	H ₂ O	4.27		41.9	(1752)
$C_{29}H_{40}N_2O_4$	Isoemetine.....	CHCl ₃	3.51		−47.4	(1752)
$C_{29}H_{42}Cl_2N_2O_4$	Dihydrochloride.....	H ₂ O	15.07		−15.6	(1752)
		H ₂ O	8.13		−5.3	
		H ₂ O	4.09		4.6	
		H ₂ O	2.26		7.7	
		H ₂ O	0.91		12.7	
$C_{29}H_{42}Br_2N_2O_4$	Dihydrobromide.....	H ₂ O	4.153		6.5	(1752)
			1.989		10.5	
$C_{33}H_{40}N_2O_{12}$	Hydrogen oxalate.....		8.019		1.6	(1752)
			3.856		6.5	
			2.958		8.5	
			1.454		11.3	
$C_{30}H_{42}N_2O_4$	<i>N</i> -Methylisoemetine.....	CHCl ₃	2.55		−50.0	(1753)
$C_{30}H_{42}N_2O_4$	<i>N</i> -Methylemetine.....	CHCl ₃	3.83		−52.6	(1752)
		CHCl ₃	4.7		−53.2	
$C_{30}H_{44}N_2O_8S \cdot 3H_2O$	Sulfate.....	H ₂ O	4.37		7.7	(1752)
$C_{30}H_{50}N_4O_{19}$	Chitin.....	HCl (concd.)			−14.1	(960)
$C_{31}H_{37}NO_{10}S$	Hydrastine <i>d</i> -camphorsulfonate.....	CHCl ₃			156	(268)
		CHCl ₃			128	
$C_{31}H_{41}NO_{10}$	Pyroaconitine.....	H ₂ O	1.121	15	−90.99	(400)
$C_{31}H_{42}BrNO_{10}$	Hydrobromide.....	H ₂ O	2.136	15	−46.8	(400)

Other alkaloids, their derivatives and other substances.—(Continued)

Formula	Name	Solvent	d, C or %	t, °C	[α] _D	Lit.
C ₃₂ H ₃₁ NO ₁₁	α-Opianlactyl narcotine.....	CHCl ₃	4.012	12	−94.73	(671)
	β-Opianlactyl narcotine.....	CHCl ₃	4.439	12.5	−103.6	
C ₃₂ H ₄₃ NO ₈	Pyroindaconitine.....	EtOH	1.62	20	91.91	(399)
C ₃₂ H ₄₄ BrNO ₈	Pyroindaconitine hydrobromide.....	H ₂ O	0.99	20	54.71	(399)
C ₃₂ H ₄₅ NO ₉	Indobenzaconine.....	EtOH	2.7	22	33.58	(399)
C ₃₃ H ₄₅ NO ₁₂	Aconitine.....	EtOH	3.726	23	11.01	(402); cf. (1017)
C ₃₃ H ₄₅ BrNO ₁₂	Aconitine hydrobromide.....	H ₂ O	1.95	20	−30.47	(402)
C ₃₂ H ₄₆ ClNO ₉	Indobenzaconine hydrochloride.....	H ₂ O	3.78	25	−7.8	(399)
C ₃₂ H ₄₈ I ₂ N ₂ O ₄	α-N-Methylemetine dimethiodide.....	H ₂ O	3.99		−2.3	(1753)
		H ₂ O	1.99		−4.5	
C ₃₂ H ₄₈ Cl ₂ N ₂ O ₄	β-N-Methylemetine dimethochloride.....	H ₂ O	0.844		68.1	(1753)
C ₃₂ H ₄₈ I ₂ N ₂ O ₄ ·H ₂ O	N-Methylisoemetine dimethiodide.....	H ₂ O	0.324		92.6	(1753)
C ₃₃ H ₄₀ N ₂ O ₁₂	Emetamine hydrogen oxalate.....	H ₂ O	3.92		−6.0	(1752)
C ₃₃ H ₄₅ NO ₁₂	Isoaconitine (napelline).....	EtOH	7.86	15	4.48	(401)
C ₃₃ H ₄₆ ClNO ₁₂	Isoaconitine hydrochloride.....	H ₂ O	1	15	−28.74	(401)
C ₃₃ H ₄₆ BrNO ₁₂	Isoaconitine hydrobromide.....	H ₂ O	1	15	−30.47	(401)
C ₃₃ H ₄₆ I ₂ NO ₁₂	Isoaconitine diiodide.....	H ₂ O	1	15	−26.94	(401)
C ₃₄ H ₄₇ NO ₁₀	Indaconitine.....	EtOH	2.28	21	18.72	(399)
C ₃₄ H ₄₅ BrNO ₁₀	Indaconitine hydrobromide.....	H ₂ O	2.99		−17.27	(399)
C ₃₄ H ₄₅ ClNO ₁₀	Indaconitine hydrochloride.....	H ₂ O	1.89	20	−35.45	(399)
C ₃₄ H ₄₉ NO ₁₀	Veratroylbikhaconine.....	EtOH	2.79	20	29.9	(399)
C ₃₅ H ₃₉ N ₆ O ₅	Ergotinine.....	EtOH	0.257	10	338	(88)
C ₃₅ H ₄₂ N ₂ O ₅	N-Benzoyl-O-methylpsycotrine.....	CHCl ₃	2.39		39.6	(1752)
C ₃₆ H ₄₄ N ₂ O ₅	Benzoylisoemetine.....	CHCl ₃	2.12		48.9	(1752)
	Benzoylmetine.....	CHCl ₃	2.37		−62.3	
C ₃₆ H ₄₆ N ₂ O ₁₀	Lycocaconitine.....	EtOH	9.30	20	42.47	(1905)
C ₃₅ H ₄₆ N ₂ O ₁₀	Myoctonine.....	EtOH	10.27	20	44.79	(1905)
C ₃₅ H ₅₁ NO ₁₁	Bikhaconitine.....	EtOH	2.609	20	12.21	(399)
C ₃₆ H ₅₂ BrNO ₁₁	Bikhaconitine hydrobromide.....	H ₂ O	3.25	16	−12.42	(399)
C ₃₅ H ₅₂ ClNO ₁₁	Bikhaconitine hydrochloride.....	H ₂ O	3.48	20	−8.86	(399)
C ₄₅ H ₄₆ N ₂ O ₁₄	Methylenedinarcotine.....	CHCl ₃	4.348		−93.4	(671)
C ₄₇ H ₆₀ O ₂₉	Gentiaacaulin.....	H ₂ O	1.82		−63.8	(246)

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Abati and de Horatis, *71*, **14**: 218; 08. (2) Abderhalden, *25*, **42**: 2331; 09. (3) Abderhalden and Baumann, *25*, **41**: 2857; 08. (4) Abderhalden and Baumann, *202*, **55**: 412; 08. (5) Abderhalden and Eichwald, *25*, **47**: 2880; 14. (6) Abderhalden and Eichwald, *25*, **48**: 113; 15. (7) Abderhalden and Eichwald, *25*, **48**: 1847; 15. (8) Abderhalden and Eichwald, *25*, **49**: 2095; 16. (9) Abderhalden and Fodor, *202*, **81**: 1; 12. (10) Abderhalden and Fodor, *25*, **49**: 561; 16. (11) Abderhalden and Guggenheim, *25*, **41**: 1237; 08. (12) Abderhalden and Guggenheim, *25*, **41**: 2852; 08. (13) Abderhalden, Hirsch and Schuler, *25*, **42**: 3394; 09. (14) Abderhalden and Hirsowski, *25*, **41**: 2840; 08. (15) Abderhalden and Kempe, *202*, **52**: 207; 07. (16) Abderhalden and Kempe, *25*, **40**: 2737; 07. (17) Abderhalden and Koelker, *202*, **55**: 416; 08. (18) Abderhalden and Weil, *202*, **84**: 39; 13. (19) Abderhalden and Wurm, *202*, **82**: 167; 12. (20) Abderhalden and Wybert, *25*, **49**: 2449; 16. (20.5) Aberson, *25*, **31**: 1432; 98. (21) Ach and Knorr, *25*, **36**: 3067; 03. (22) Ageno and Valla, *24*, **14**: 331; 12. (23) Ageno and Valla, *36*, **43** II: 163; 13. (24) Aignan, *34*, **112**: 1009; 91. (25) Allen and Tollens, *13*, **260**: 289; 90. (26) Allen and Tollens, *13*, **260**: 306; 90. (27) Amenomiya, *293*, **240**: 498; 02. (28) Anderson, *50*, **20**: 269; 16. (29) Andreocci, *22*, **4** I: 164; 95. (30) Andres and Andreev, *25*, **25**: 609; 92. (31) Andrews, *4*, **99**: 1871; 11. (32) Andrlík, *445*, **53**: 948; 03. (33) Angelico, *36*, **39** I: 296; 09. (34) Annett, *4*, **123**: 376; 23. (35) Anschütz, *25*, **13**: 1538; 80. (36) Anschütz, *25*, **18**: 1397; 85. (37) Anschütz and Pictet, *25*, **13**: 1175; 80. (38) Anschütz and Reitter, *7*, **16**: 493; 95. (39) Antrick, *25*, **20**: 310; 87. (40) Armstrong and Lowry, *4*, **81**: 1441; 02. (41) Armstrong and Lowry, *4*, **81**: 1462; 02. (42) Armstrong and Lowry, *4*, **81**: 1469; 02. (43) Armstrong and Pope, *4*, **59**: 315; 91. (44) Armstrong and Robertson, *4*, **87**: 1272; 05. (45) Armstrong and Walker, *5*, **90**: 375; 14. (46) Arnaud, *34*, **93**: 593; 81. (46.5) Arnaud, *34*, **97**: 174; 83. (47) Arnaud, *34*, **107**: 1162; 88. (48) Arndtsen, *6*, **54**: 403; 58. (49) Arndtsen, *8*, **105**: 312; 58. (50) Arth, *6*, **7**: 433; 86. (51) von Arx, *Thesis*, Zürich, 1919. *10*, **5**: 727; 25. (52) Asahina, *293*, **245**: 325; 07. (53) Asahina, *25*, **45**: 2363; 12. (54) Asahina, *25*, **46**: 1775; 13. (55) Asahina and Momoya, *293*, **252**: 56; 14. (56) Asahina and Sugii, *293*, **251**: 357; 13. (57) Aschan, *426*, **21**: No. 5; 95. (58) Aschan, *25*, **28**: 16; 95. (59) Aschan, *25*, **40**: 2750; 07. (60) Aschan, *13*, **398**: 299; 12. (61) Aschan, *13*, **410**: 222; 15. (62) Aschan, *13*, **410**: 240; 15. (63) Aston, *4*, **97**: 1381; 10. (64) Atkinson and Yoshida, *4*, **41**: 49; 82. (65) Atterburg, *25*, **10**: 1202; 77. (66) Aubry, *49*, **10**: 202; 14. (66.5) Auerbach and Krüger, *279*, **46**: 97; 23. (67) Austerweil and Cochlin, *34*, **150**: 1693; 10. (68) Backer and de Boer, *64P*, **26**: 79; 23. (69) Backer and de Boer, *70*, **43**: 297; 24. (70) Backer and de Boer, *70*, **43**: 420; 24. (71) Baeyer, *25*, **28**: 639; 95. (72) Baker and Pope, *4*, **77**: 696; 00. (73) Baker and Smith, *Researches on the pines of Australia*. Sydney, 1910. (74) Bamberger, *25*, **23**: 291; 90. (75) Bondzynski, *25*, **29**: 476; 96. (76) Bondzynski and Humnicki, *202*, **22**: 396; 97. (77) Barbier, *27*, **9**: 914; 92. (78) Barbier, *34*, **114**: 126; 92. (79) Barbier, *34*, **114**: 674; 92. (80) Barbier, *27*, **9**: 998; 93. (81) Barbier, *34*, **116**: 993; 93. (82) Barbier, *34*, **116**: 1459; 93. (82.5) Barbier and Bouveault, *34*, **122**: 529; 96. (83) Barbier and Grignard, *34*, **147**: 597; 08. (84) Barbier and Hilt, *34*, **108**: 519; 89. (85) Barbier and Locquin, *14*, **2**: 389; 15. (86) Bargellini, *172* (7th), **4A**: 332; 10. (87) Barger, *4*, **97**: 466; 10. (88) Barger and Carr, *4*, **91**: 337; 07. (89) Barger and Ewins, *4*, **97**: 284; 10. (90) Barrowclift and Tutin, *4*, **95**: 1966; 09. (91) Basquin, *Thesis*, Zürich, 1915. *10*, **4**: 584; 21. (92) Bates and Jackson, *31A*, **13**: 127; 17. (93) Bau, *136*, **21**: 185; 97. (93.5) Bau, *282*, **16**: 397; 99. (94) Bau, *136*, **26**: 69; 02. (95) Bau, *445*, **54**: 481; 04. (95.5) Bauer, *518*, **36**: 304; 89. (96) Baumann, *25*, **15**: 1731; 82. (97) Baumann, *202*, **8**: 299; 84. (98) Béchaump, *34*, **39**: 653; 54. (99) Beckel, *293*, **249**: 329; 11. (100) Becker, *25*, **14**: 1028; 81. (101) Beckmann, *13*, **250**: 322; 89. (102) Beckmann, *13*, **292**: 1; 96. (103) Beckmann, *52*, **55**: 14; 97. (103.5) Beckmann, *52*, **55**: 31; 97. (104) Beckmann and Eickelberg, *25*, **29**: 418; 96. (105) Beckmann and Pleissner, *13*, **262**: 1; 91. (106) Béhal, *6*, **20**: 411; 00. (107) Behrend, *13*, **353**: 106; 07. (108) Behrend and Lohr, *13*, **362**: 78; 08. (109) Bennet and Gibson, *4*, **123**: 1570; 23. (110) Berend, *25*, **11**: 1353; 78. (111) Berend and Herms, *52*, **74**: 112; 06. (111.5) Bergmann, Kobel, Schotte, Rennert and Ludewig, *13*, **434**: 79; 23. (112) Bergmann, Schotte and Leschinsky, *25*, **56**: 1052; 23. (113) Bergmann and Wolff, *25*, **56**: 1060; 23. (114) Berkenheim, *25*, **25**: 686; 92. (115) Berlingozzi, *36*, **50** II: 281; 20. (116) Bernheimer, *36*, **13**: 451; 83. (117) Berthelot, *6*, **40**: 5; 54. (118) Berthelot, *6*, **46**: 66; 56. (119) Berthelot, *49*, **29**: 38; 54. (119.5) Berthelot, *6*, **55**: 269; 59.

- (120) Berthelot, 167, 1862: 441. (121) Berthelot, 167, 1862: 456. (122) Bertolo, 36, 41 I: 705; 11. (123) Bertolo, 36, 53: 721; 23. (124) Bertolo and Ranfaldi, 36, 35 II: 235; 05. (125) Bertossa, *Thesis*, Zürich, 1916. 10, 4: 584; 21. (125-05) Bertram and Gildemeister, 52, 49: 185; 94. (125-1) Bertram and Helle, 52, 61: 293; 00. (125-5) Bertram and Walbaum, 52, 49: 15; 94. (126) Bertrand, 27, 5: 554; 91. (127) Bertrand, 34, 139: 802; 04. (128) Bertrand, 27, 31: 1289; 04. (129) Bertrand, 34, 147: 201; 08. (130) Bertrand, 34, 150: 180; 10. (131) Bertrand and Bruneau, 34, 146: 482; 08. (132) Bertrand and Lanzenberg, 34, 143: 291; 06. (133) Bertrand and Weisweiler, 27, 9: 38; 11. (136) Betti, 36, 36 II: 392; 06. (137) Betti, 36, 36 II: 666; 06. (138) Betti, 36, 37 I: 62; 07. (139) Betti, 36, 37 II: 5; 07. (140) Betti and Capaccioli, 36, 50 II: 276; 20. (141) Betti and Conestabile, 36, 46 I: 200; 16. (142) Betti and Mayer, 25, 41: 2071; 08. (143) Beyer, 293, 221: 283; 83. (144) Biland, *Thesis*, Zürich, 1915. 10, 4: 584; 21. (144-5) Binz, in Wallach, 13, 277: 154; 93. (145) Binz, 7, 12: 723; 93. (145-5) Biot, 151, 15: 93; 38. (146) Biot, 151, 16: 229; 38. (146-5) Biot, 6, 28: 99; 50. (147) Biot, 6, 36: 257; 52. (148) Bisehoff and Walden, *Handbuch der Stereochemie*, p. 220. Frankfurt, 1894. (149) Blaise, 34, 132: 478; 01.
- (150) Blaise and Mareilly, 27, 31: 317; 04. (151) Blanksma and van Ekenstein, 176, 5: 777; 08. (152) Bleyer and Paczowski, 202, 84: 1; 13. (153) Bloeh, 27, 31: 71; 04. (154) Blumann and Zeitschel, 25, 46: 1178; 13. (155) Bodart, 57, 23: 1; 02. (156) Boedtker, 34, 145: 329; 07. (157) Boedtker, 34, 154: 437; 12. (158) Boedtker, 27, 17: 360; 15. (159) Böhm, in Ritt-hausen and Weger, 52, 30: 32; 84.
- (160) Böhme, 293, 241: 1; 03. (161) de Boer, *Thesis*, Groningen, 1923. (162) Horowitz, Böttcher and Horowitz, 57, 32: 793; 11. (163) Böttcher and 57, 33: 567; 12. (164) Bondonneau, 27, 25: 2; 76. (165) Borzekowski, *Thesis*, Zürich, 1913. 10, 4: 584; 21. (166) Bosshart, *Thesis*, Zürich, 1914. 10, 4: 584; 21. (167) Bouchardat, 34, 19: 1174; 44. (168) Bouchardat, 6, 27: 68; 145; 72. (169) Bouchardat, 34, 102: 435; 86.
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- (1010) Jones and Millington, 201, 12: 489; 04. (1011) de Jong, 70, 42: 980; 23. (1012) Jowett, 135, 74: 120; 96. (1013) Jowett, 4, 77: 473; 00. (1014) Jowett, 4, 77: 851; 00. (1015) Jowett, 4, 79: 580; 01. (1015.5) Jowett, 4, 79: 1331; 01. (1016) Jowett and Pyman, 4, 103: 290; 13. (1017) Jürgens, 167, 1885: 1722. 498, 24: 721, 745, 762, 778, 794; 85. (1018) Jungfleisch, 34, 110: 790; 90. (1019) Jungfleisch and Godchot, 34, 140: 719; 05.
- (1020) Jungfleisch and Godchot, 34, 141: 111; 05. (1021) Jungfleisch and Godchot, 34, 142: 637; 06. (1022) Jungfleisch and Grimbirt, 34, 107: 390; 88. (1023) Jungfleisch and Leger, 34, 105: 1255; 87. (1024) Jungfleisch and Leger, 34, 106: 357; 88. (1025) Jungfleisch and Leger, 34, 106: 657; 88. (1026) Jungfleisch and Leger, 27, 49: 743; 88. (1027) Jungfleisch and Leger, 34, 108: 952; 89. (1028) Jungfleisch and Leger, 34, 114: 1192; 92. (1029) Jungfleisch and Leger, 34, 118: 29; 94.
- (1030) Jungfleisch and Leger, 34, 119: 1268; 94. (1031) Jungfleisch and Leroux, 34, 144: 1435; 07. (1032) Jungfleisch and Leroux, 34, 147: 862; 08. (1033) Just, 13, 220: 146; 83. (1034) Kachler, 13, 197: 86; 79. (1035) Kallenberg, 25, 56: 316; 23. (1036) Karpf, *Thesis*, Zürich, 1915. 10, 4:
- 584; 21. (1037) Karrer, 25, 49: 1644; 16. (1038) Karrer and Kaase, 37, 2: 436; 19. (1039) Karrer, Salmon and Peyer, 37, 6: 3; 23.
- (1040) Karrer and Schlosser, 37, 6: 411; 23. (1041) Karrer, Widmer and Staub, 13, 433: 288; 23. (1042) Karrer and Zega, 37, 6: 822; 23. (1043) Kaufmann, 25, 46: 1823; 13. (1044) Kaufmann and Fuchs, 25, 56: 2527; 23. (1045) Kaufmann and Huber, 25, 46: 2913; 13. (1046) Kay, 13, 362: 325; 08. (1047) Kay, 4, 95: 560; 09. (1048) Kay and Perkin, 4, 89: 839; 06. (1048.5) Kazay, 515, 24: 23; 20. (1049) Kelch, *Thesis*, Zürich, 1912. 10, 4: 584; 21.
- (1050) Kent and Tollens, 25, 17: 668; 84. (1051) Kenyon, 4, 105: 2226; 14. (1052) Kenyon and McNicol, 4, 123: 14; 23. (1052.5) Kenyon and Pickard, 4, 105: 2262; 14. (1053) Kenyon and Pickard, 4, 105: 2644; 14. (1054) Kenyon and Pickard, 4, 105: 2677; 14. (1055) Kenyon and Pickard, 4, 107: 35; 15. (1056) Kenyon and Pickard, 4, 107: 115; 15. (1057) Kiliani, 25, 15: 2953; 82. (1058) Kiliani, 25, 16: 2625; 83. (1059) Kiliani, 25, 19: 767; 86.
- (1060) Kiliani, 25, 19: 1914; 86. (1061) Kiliani, 25, 19: 3029; 86. (1062) Kiliani, 25, 24: 339; 91. (1063) Kiliani, 25, 25: 2116; 92. (1064) Kiliani, 293, 234: 438; 96. (1065) Kiliani and Matthes, 25, 40: 1238; 07. (1066) Kiliani and Sanda, 25, 26: 1649; 93. (1067) Kiliani and Sautermeister, 25, 40: 4294; 07. (1068) King, *Thesis*, Zürich, 1912. 10, 4: 584; 21. (1069) Kipping, 4, 77: 861; 00.
- (1070) Kipping, 4, 79: 370; 01. (1071) Kipping, 4, 81: 275; 02. (1072) Kipping, 4, 93: 457; 08. (1073) Kipping, 4, 95: 408; 09. (1074) Kipping and Challenger, 4, 99: 626; 11. (1075) Kipping and Davies, 4, 95: 69; 09. (1076) Kipping and Hall, 4, 79: 430; 01. (1077) Kipping and Hall, 4, 79: 442; 01. (1078) Kipping and Hunter, 4, 81: 574; 02. (1079) Kipping and Hunter, 4, 83: 1005; 03.
- (1080) Kipping and Pope, 4, 63: 548; 93. (1081) Kipping and Salway, 4, 85: 438; 04. (1082) Kižer, 53, 31: 872; 99. (1083) Kižer, 53, 39: 1240; 07. (1084) Kižer, 53, 39: 1246; 07. (1085) Kizhner, 53, 43: 582; 11. (1086) Kizhner, 53, 43: 1554; 11. (1087) Kizhner and Zavadovskii, 53, 43: 1132; 11. (1088) Klages, 25, 39: 2131; 06. (1089) Klages, 25, 29: 2306; 06.
- (1090) Klages, 25, 40: 2360; 07. (1091) Klages and Sautter, 25, 37: 649; 04. (1092) Klages and Sautter, 25, 38: 2312; 05. (1093) Klages and Sautter, 25, 39: 1938; 06. (1094) Klason and Köhler, 19, 2: No. 3; 05. (1095) Klimenko, 53, 12: 17; 80. (1096) Klobb, 27, 27: 1229; 02. (1097) Klobb, 34, 148: 1272; 02. (1098) Klobb, 6, 22: 5; 11. (1099) Klobb, 6, 24: 134; 11.
- (1100) Klobb, 6, 24: 410; 11. (1101) Knoevenagel and Samel, 25, 39: 677; 06. (1102) Knorr, 25, 27: 1144; 94. (1103) Knorr, 25, 37: 3172; 04. (1104) Knorr, Butler and Hörlein, 13, 368: 305; 09. (1105) Knorr and Hartmann, 25, 45: 1350; 12. (1106) Knorr and Hawthorne, 25, 35: 3010; 02. (1107) Knorr and Hörlein, 25, 40: 2032; 07. (1108) Knorr and Hörlein, 25, 40: 4883; 07. (1109) Knorr and Hörlein, 25, 40: 4889; 07.
- (1110) Knorr, Hörlein and Grimme, 25, 40: 3844; 07. (1111) Knorr, Hörlein and Staubach, 25, 42: 3511; 09. (1112) Knorr, Hörlein and Staubach, 25, 42: 3521; 09. (1113) Knorr and Raabe, 25, 41: 3050; 08. (1114) Knorr and Smiles, 25, 35: 3009; 02. (1115) Knorr and Waehtig, 25, 40: 3860; 07. (1117) Koenigs, 13, 347: 143; 06. (1118) Koenigs and Knorr, 25, 34: 957; 01. (1119) Koenigs and Knorr, 25, 23: 4343; 01.
- (1120) Koenigs and Mylo, 25, 41: 4427; 08. (1120.5) Körner and Vanzetti, *Mem. acad. Linc.*, 8: 749; 11. (1121) Kötze and Schwarz, 13, 357: 209; 07. (1122) Kolm, 57, 33: 447; 12. (1123) Komatsu, 429, 1: 123; 15. (1124) Komppa and Hintikka, 25, 46: 645; 13. (1125) Kondakov, 136, 26: 720; 02. (1126) Kondakov, 52, 67: 280; 03. (1127) Kondakov, 52, 79: 271; 09. (1128) Kondakov and Lučinin, 52, 60: 257; 99. (1129) Kondakov and Schindelmeyer, 52, 67: 193; 03.
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- (1140) Küster and Hügel, 202, 130: 1; 23. (1141) Kuhn, 25, 56: 857; 23. (1142) Kuntner, *Thesis*, Zürich, 1913. 10, 4: 584; 21. (1143) Kuriloff, 52, 45: 123; 92. (1144) Kursanov, 53, 53: 289; 01. (1145) Lacroix, 49, 22: 99; 05. (1146) Lacroix, 49, 24: 493; 06. (1147) Ladenburg, 13, 247: 1; 88. (1148) Ladenburg, 25, 21: 3065; 88. (1149) Ladenburg, 25, 26: 854; 93.
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- (1160) Landolt, 25, 6: 1073; 73. (1161) Landolt, 13, 189: 241; 77. (1162) Landolt, *Das optische Drehungsvermögen*. Braunschweig, 1st ed., 1879; 2nd ed., 1898. (1162.5) Landolt, 25, 13: 2329; 80. (1163) Landolt, 25, 19: 157; 86. (1164) Landolt, 25, 21: 191; 88. (1165) Landwehr, 202, 8: 165; 84.

- (¹¹⁸⁶) Langheld, *25*, **41**: 378; 08. (¹¹⁶⁷) Lapworth, *4*, **77**: 1053; 00. (¹¹⁶⁸) Lapworth, *4*, **83**: 1114; 03. (¹¹⁶⁹) Lapworth, *4*, **89**: 945; 06. (¹¹⁷⁰) Lapworth, *4*, **89**: 1819; 06. (¹¹⁷¹) Lapworth and Hann, *4*, **81**: 1499; 02. (¹¹⁷²) Lapworth and Hann, *4*, **81**: 1508; 02. (¹¹⁷³) Lapworth and Harvey, *4*, **81**: 549; 02. (¹¹⁷⁴) Lapworth and Steele, *4*, **99**: 1877; 11. (¹¹⁷⁵) Lapworth and Wechsler, *4*, **91**: 977; 07. (¹¹⁷⁶) Lapworth and Wechsler, *4*, **97**: 38; 10. (¹¹⁷⁷) Latschinoff, *25*, **13**: 1052; 80. (¹¹⁷⁸) Latschinoff, *25*, **19**: 474; 86. (¹¹⁷⁹) Leach, *4*, **87**: 413; 05. (¹¹⁸⁰) Le Bel, *34*, **77**: 1021; 73. (¹¹⁸¹) Le Bel, *27*, **21**: 542; 74. (¹¹⁸²) Le Bel, *27*, **25**: 545; 76. (¹¹⁸³) Lees, *4*, **85**: 639; 04. (¹¹⁸⁴) Lees, *4*, **91**: 1408; 07. (¹¹⁸⁵) Lefebure, *49*, **26**: 241; 07. (¹¹⁸⁶) Léger, *34*, **111**: 109; 90. (¹¹⁸⁷) Léger, *34*, **117**: 110; 93. (¹¹⁸⁸) Léger, *34*, **155**: 172; 12. (¹¹⁸⁹) Léger, *34*, **158**: 1189; 14. (¹¹⁹⁰) Léger, *34*, **162**: 506; 16. (¹¹⁹¹) Léger and Roques, *34*, **155**: 1088; 12. (¹¹⁹²) Léger and Roques, *34*, **156**: 1687; 13. (¹¹⁹³) Lehrfeld, *Thesis*, Zürich, 1915. *10*, **4**: 584; 21. (¹¹⁹⁴) Lellmann, *13*, **259**: 193; 90. (¹¹⁹⁵) Lendrich, Koek and Schwarz, *279*, **22**: 441; 11. (¹¹⁹⁶) Lenz, *91*, **27**: 549; 88. (¹¹⁹⁷) Leone and d'Emilio, *36*, **40 I**: 556; 10. (¹¹⁹⁸) Lepékin, *53*, **40**: 698; 08. (¹¹⁹⁹) Leroide, *34*, **148**: 1611; 09. (¹²⁰⁰) Leser, *27*, **25**: 196; 01. (¹²⁰¹) Le Sueur, *4*, **93**: 716; 08. (¹²⁰²) Le Sueur, *4*, **103**: 2108; 13. (¹²⁰³) Letsche, *202*, **60**: 462; 09. (¹²⁰⁴) Leuchs, *25*, **41**: 1711; 08. (¹²⁰⁵) Leuchs, *25*, **46**: 2435; 13. (¹²⁰⁶) Leuchs, *25*, **48**: 1015; 15. (¹²⁰⁷) Leuchs and Brewster, *25*, **45**: 201; 12. (¹²⁰⁸) Leuchs and Brewster, *25*, **46**: 986; 13. (¹²⁰⁹) Leuchs and Gladkorn, *25*, **56**: 1780; 23. (¹²¹⁰) Leuchs, Gladkorn and Hellriegel, *25*, **56**: 2472; 23. (¹²¹¹) Leuchs and Greiger, *25*, **42**: 3067; 09. (¹²¹²) Leuchs and Rauch, *25*, **46**: 3917; 13. (¹²¹³) Leuchs and Rauch, *25*, **47**: 370; 14. (¹²¹⁴) Leuchs and Schneider, *25*, **42**: 2494; 09. (¹²¹⁵) Leuchs and Schneider, *25*, **42**: 2681; 09. (¹²¹⁶) Leuchs and Weber, *25*, **42**: 770; 09. (¹²¹⁷) Leuchs and Wutke, *25*, **45**: 3686; 12. (¹²¹⁸) Leuchs and Wutke, *25*, **46**: 2420; 13. (¹²¹⁹) Leuckart and Bach, *25*, **20**: 104; 87. (¹²²⁰) Levene, *141*, **24**: 59; 16. (^{1220.5}) Levene, *141*, **24**: 69; 16. (¹²²¹) Levene, *141*, **26**: 143; 16. (¹²²²) Levene, *141*, **26**: 155; 16. (¹²²³) Levene, *141*, **26**: 367; 16. (¹²²⁴) Levene, *141*, **57**: 323; 23. (¹²²⁵) Levene, *141*, **57**: 337; 23. (¹²²⁶) Levene, *141*, **59**: 123; 24. (¹²²⁷) Levene, *141*, **59**: 135; 24. (¹²²⁸) Levene, *141*, **59**: 141; 24. (¹²²⁹) Levene and Jacobs, *25*, **42**: 2102; 09. (¹²³⁰) Levene and Jacobs, *25*, **42**: 3247; 09. (¹²³¹) Levene and La Forge, *25*, **45**: 608; 12. (¹²³²) Levene and La Forge, *141*, **15**: 155; 13. (¹²³³) Levene and La Forge, *141*, **15**: 481; 13. (¹²³⁴) Levene and Meyer, *141*, **26**: 355; 16. (¹²³⁵) Levene and Meyer, *141*, **55**: 221; 23. (¹²³⁶) Levene and Meyer, *141*, **57**: 319; 23. (¹²³⁷) Levene and Meyer, *141*, **59**: 145; 24. (¹²³⁸) Levene and Mikeska, *141*, **55**: 795; 23. (¹²³⁹) Levene and West, *141*, **26**: 115; 16. (¹²⁴⁰) Levy and Wolfenstein, *25*, **28**: 2270; 95. (¹²⁴¹) Levy and Wolfenstein, *25*, **29**: 1960; 96. (¹²⁴²) Lewkowitsch, *25*, **16**: 1568; 83. (¹²⁴³) Lewkowitsch, *25*, **16**: 2720; 83. (¹²⁴⁴) Lewkowitsch, *25*, **17**: 1439; 84. (¹²⁴⁵) Liebermann, *25*, **21**: 2342; 88. (^{1245.5}) Liebermann, *25*, **24**: 606; 91. (¹²⁴⁶) Liebermann, *25*, **40**: 3602; 07. (¹²⁴⁷) Liebermann and Giesel, *25*, **23**: 926; 90. (¹²⁴⁸) Liebermann and Hörmann, *25*, **11**: 952; 78. (¹²⁴⁹) Lifschitz, *7*, **105**: 27; 23. (¹²⁵⁰) Likiernik, *202*, **15**: 415; 90. (¹²⁵¹) Lindenmeyer, *52*, **90**: 321; 63. (¹²⁵²) Lintner and Düll, *92*, **1892**: 263. (¹²⁵³) Lintner and Düll, *516*, **17**: 339; 94. (¹²⁵⁴) Lintner and Liebig, *202*, **88**: 109; 13. (¹²⁵⁵) Lipp, *13*, **382**: 265; 11. (¹²⁵⁶) Lipp, *13*, **339**: 241; 13. (^{1256.5}) Lipp, *25*, **56**: 2098; 23. (¹²⁵⁷) Lippmann, *13*, **219**: 173; 83. (¹²⁵⁸) Lippmann, *25*, **17**: 2239; 84. (¹²⁵⁹) Lippmann, *25*, **17**: 2835; 84. (¹²⁶⁰) Lippmann, *25*, **20**: 1001; 87. (¹²⁶¹) Lippmann, *25*, **28**: 1971; 95. (¹²⁶²) Lobry de Bruyn and van Ekenstein, *70*, **20**: 331; 01. (^{1262.5}) Lobry de Bruyn and van Ekenstein, *70*, **21**: 310; 02. (¹²⁶³) Lobry de Bruyn and van Ekenstein, *25*, **35**: 3079; 02. (¹²⁶⁴) Lobry de Bruyn and van Ekenstein, *64P*, **5**: 175; 02. (¹²⁶⁵) Loequin, *27*, **1**: 595; 07. (¹²⁶⁶) Löffler, *25*, **37**: 1879; 04. (¹²⁶⁷) Löffler and Grunert, *25*, **40**: 1342; 07. (¹²⁶⁸) Löffler and Kirschner, *25*, **38**: 3329; 05. (¹²⁶⁹) Löffler and Tschunke, *25*, **42**: 929; 09. (¹²⁷⁰) Loiseau, *34*, **82**: 1058; 76. (¹²⁷¹) Long, *12*, **36**: 351; 88. (¹²⁷²) Long, *12*, **38**: 264; 89. (¹²⁷³) Long, *12*, **40**: 275; 90. (¹²⁷⁴) Long, *1*, **14**: 149; 92. (¹²⁷⁵) Long, *J. Anal. Appl. Chem.*, **7**: 99; 93. (¹²⁷⁶) Long, *1*, **21**: 637; 99. (¹²⁷⁷) Long, *1*, **23**: 813; 01. (¹²⁷⁸) Long, *1*, **27**: 363; 05. (¹²⁷⁹) Longchambon, *34*, **175**: 174; 22. (¹²⁸⁰) Longchambon, *34*, **178**: 951; 24. (¹²⁸¹) Louvrier, *Thesis*, Paris, 1910. *10*, **4**: 589; 21. *14*, **9**: 189; 18. (¹²⁸³) Lovén, *52*, **78**: 63; 08. (¹²⁸⁴) Lovén and Ohlsson, *25*, **47**: 1534; 14. (¹²⁸⁵) Lowry, *4*, **73**: 569; 98. (^{1285.5}) Lowry, *4*, **73**: 986; 98. (¹²⁸⁶) Lowry, *4*, **75**: 211; 99. (^{1286.5}) Lowry, *4*, **83**: 953; 03. (¹²⁸⁷) Lowry, *4*, **85**: 1551; 04. (¹²⁸⁸) Lowry, *5*, **81**: 472; 08. (¹²⁸⁹) Lowry, *133*, **1912**: 419. (¹²⁹⁰) Lowry, *4*, **103**: 1062; 13. (¹²⁹¹) Lowry, *62*, **212**: 261; 13. 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(¹³¹¹) Luff and Kipping, *4*, **93**: 2090; 08. (^{1311.5}) Luff and Kipping, *4*, **95**: 1993; 09. (¹³¹²) Luff and Perkin, *4*, **99**: 518; 11. (¹³¹³) Lustgarten, *57*, **2**: 626; 81. (^{1313.5}) Lutz, *Diss.*, Rostock, 1899. (¹³¹⁴) Lutz, *25*, **35**: 2460; 02. (¹³¹⁵) Lutz, *25*, **37**: 2123; 04. (¹³¹⁶) Lutz, *52*, **70**: 1; 04. (¹³¹⁷) Lutz, *25*, **41**: 841; 08. (¹³¹⁸) Lutz, *7*, **70**: 256; 10. (¹³¹⁹) McCrae, *4*, **79**: 1103; 01. (¹³²⁰) McCrae, *4*, **81**: 1221; 02. (¹³²¹) McCrae, *4*, **83**: 1324; 03. (¹³²²) McCrae and Patterson, *4*, **77**: 1096; 00. (¹³²³) MacDonald, *4*, **103**: 1896; 13. (¹³²⁴) Mach, *57*, **15**: 627; 94. (^{1324.2}) Macheleidt in Wallach, *13*, **270**: 171; 92. (^{1324.5}) MacKenzie, *4*, **75**: 964; 99. (¹³²⁵) MacKenzie, *4*, **81**: 1402; 02. (¹³²⁶) MacKenzie, *4*, **85**: 1249; 04. (¹³²⁷) MacKenzie, *4*, **89**: 365; 06. (¹³²⁸) MacKenzie, *182*, **27**: 150; 11. (¹³²⁹) MacKenzie, *4*, **101**: 1196; 12. (¹³³⁰) MacKenzie and Barrow, *4*, **99**: 1910; 11. (¹³³¹) MacKenzie and Bate, *4*, **107**: 1681; 15. (¹³³²) MacKenzie and Clough, *4*, **93**: 811; 08. (¹³³³) MacKenzie and Clough, *4*, **95**: 777; 09. (¹³³⁴) MacKenzie and Clough, *4*, **97**: 1016; 10. (¹³³⁵) MacKenzie and Clough, *4*, **97**: 2564; 10. (¹³³⁶) MacKenzie and Clough, *4*, **101**: 390; 12. (¹³³⁷) MacKenzie and Clough, *4*, **103**: 687; 13. (¹³³⁸) MacKenzie, Drew and Martin, *4*, **107**: 26; 15. (¹³³⁹) MacKenzie and Ghosh, *68*, **35**: 22; 15. (¹³⁴⁰) MacKenzie and Ghosh, *68*, **36**: 204; 17. (¹³⁴¹) MacKenzie and Humphries, *4*, **95**: 1105; 09. (¹³⁴²) MacKenzie and Humphries, *4*, **97**: 121; 10. (¹³⁴³) MacKenzie and Martin, *4*, **103**: 112; 13. (¹³⁴⁴) MacKenzie, Martin and Rule, *4*, **105**: 1583; 14. (^{1344.5}) MacKenzie and Müller, *4*, **95**: 544; 09. (¹³⁴⁵) MacKenzie and Plenderleith, *4*, **123**: 1090; 23. (¹³⁴⁶) MacKenzie and Smith, *4*, **123**: 1962; 23. (¹³⁴⁷) MacKenzie and Thompson, *4*, **87**: 1004; 05. (¹³⁴⁸) MacKenzie and Thompson, *4*, **91**: 789; 07. (¹³⁴⁹) MacKenzie and Walker, *4*, **107**: 1685; 15. (¹³⁵⁰) MacKenzie and Widdows, *4*, **107**: 702; 15. (¹³⁵¹) MacKenzie and Wood, *4*, **115**: 828; 19. (¹³⁵²) MacKenzie and Wren, *4*, **89**: 688; 06. (¹³⁵³) MacKenzie and Wren, *4*, **91**: 1215; 07. (¹³⁵⁴) MacKenzie and Wren, *4*, **93**: 309; 08. (¹³⁵⁵) MacKenzie and Wren, *4*, **97**: 473; 10. (¹³⁵⁶) MacKenzie and Wren, *4*, **97**: 1355; 10. (¹³⁵⁷) MacKenzie and Wren, *4*, **117**: 680; 20. (^{1357.5}) Magnus-Levy, *205*, **2**: 319; 07. (¹³⁵⁸) Magnus-Levy, *205*, **6**: 502; 07. (¹³⁵⁹) Mahla, *25*, **34**: 3777; 01. (¹³⁶⁰) Mahlberg, *Akad. Afhand. Upsal.*, **1914**. *10*, **4**: 1092; 21. (¹³⁶¹) de Malleman, *34*, **172**: 150; 21. (¹³⁶²) de Malleman, *34*, **173**: 474; 22. (¹³⁶³) de Malleman, *51*, **4**: 18; 23. (¹³⁶⁴) Malosse, *34*, **153**: 54; 11. (¹³⁶⁵) Malosse, *27*, **15**: 358; 14. (¹³⁶⁶) Mameli, *36*, **37 II**: 483; 07. (¹³⁶⁷) Mameli, *36*, **42 II**: 546; 12. (¹³⁶⁸) Manasse, *25*, **35**: 3811; 02. (¹³⁶⁹) Maquenne, *34*, **106**: 286; 88. (¹³⁷⁰) Maquenne, *34*, **109**: 812; 89. (¹³⁷¹) Maquenne, *34*, **109**: 968; 89. (¹³⁷²) Maquenne, *34*, **130**: 1402; 00. (¹³⁷³) Maquenne, *27*, **23**: 587; 00. (¹³⁷⁴) Maquenne and Bertrand, *34*, **132**: 1419; 01. (¹³⁷⁵) Maquenne and Goodwin, *27*, **31**: 1075; 04. (¹³⁷⁶) Marckwald, *25*, **35**: 1602; 02. (¹³⁷⁷) Marckwald, *25*, **37**: 1038; 04. (¹³⁷⁸) Marckwald and Karzag, *25*, **42**: 1518; 09. (¹³⁷⁹) Marckwald and MacKenzie, *25*, **34**: 485; 01. (¹³⁸⁰) Marckwald and Meth, *25*, **38**: 801; 05. (¹³⁸¹) Marckwald and Meth, *25*, **39**: 1171; 06. (¹³⁸²) Marino-Zuco and Pasquero, *36*, **41 II**: 368; 11. (¹³⁸³) Marko, *13*, **362**: 333; 08. (¹³⁸⁴) Markovnikov, *53*, **35**: 226; 03. (¹³⁸⁵) Markovnikov and Reformatsky, *52*, **48**: 293; 93. (¹³⁸⁶) Markovnikov and Stadnikov, *53*, **35**: 389; 03. (¹³⁸⁷) Marquis, *498*, **16**: 449, 481, 513; 77. (¹³⁸⁸) Marsh, *135*, **60**: 307; 89. (¹³⁸⁹) Marsh, *4*, **57**: 828; 90. (¹³⁹⁰) Marsh and Cousins, *4*, **59**: 966; 91. (¹³⁹¹) Marsh and Gardner, *4*, **65**: 35; 94. (¹³⁹²) Marsh and Gardner, *135*, **74**: 279; 96. (¹³⁹³) Marsh and Struthers, *4*, **95**: 1777; 09. (¹³⁹⁴) Martine, *34*, **134**: 1437; 02. (¹³⁹⁶) Martine, *6*, **9**: 49; 04. (¹³⁹⁶) Mascarelli, *36*, **45 I**: 127; 15. (¹³⁹⁷) Mascarelli and Nigrisali, *22*, **23 II**: 276; 14. (¹³⁹⁸) Mascarelli and Nigrisali, *36*, **45 I**: 106; 15. (¹³⁹⁹) Masson, *345*, **18**: 283, 477; 11. (¹⁴⁰⁰) Masson, *34*, **154**: 517; 12. (¹⁴⁰¹) Mauthner, *57*, **3**: 343; 83. (^{1401.5}) Mauthner, *202*, **7**: 222; 83. (¹⁴⁰²) Mauthner, *57*, **27**: 421; 06. (¹⁴⁰³) Mauthner, *57*, **28**: 1113; 07. (¹⁴⁰⁴) Mauthner, *57*, **30**: 635; 09. (^{1404.5}) Mauthner, *144*, **31**: 89; 13. (^{1404.8}) Mauthner, *144*, **32**: 000; 14. (¹⁴⁰⁵) Mayer, *205*, **1**: 39; 06. (¹⁴⁰⁶) Mayer, *205*, **9**: 439; 08. (¹⁴⁰⁷) Mayer, *205*, **17**: 145; 09. (¹⁴⁰⁸) Mayer and Tollens, *25*, **40**: 2434; 07. (¹⁴⁰⁹) Mazzucchelli, Ranucci and Sabatini, *36*, **43 II**: 26; 14. (¹⁴¹⁰) Mazzucchelli and Sabatini, *36*, **45 II**: 225; 15. (¹⁴¹¹) Meerwein and Gerard, *13*, **435**: 174; 23. (^{1411.5}) Meisenheimer, *13*, **385**: 117; 11. (¹⁴¹²) Meisenheimer and Lichtenstadt, *25*, **44**: 356; 11. (¹⁴¹³) Meissl, *52*, **22**: 97; 80. (¹⁴¹⁴) Menozzi and Appiani, *36*, **22 II**: 105; 92. (¹⁴¹⁶) Menozzi and Appiani, *22*, **2**: 415; 93. (¹⁴¹⁶) Menozzi and Moreschi, *22*, **17 I**: 95; 08. (¹⁴¹⁷) Merck, *293*, **229**: 161; 91. (¹⁴¹⁸) Merck, *293*, **231**: 117; 93. (¹⁴¹⁹) Meulenhoff, *Nederl. Tijdsch. Pharm.*, **5**: 258. *185*, **1893 II**: 761. (¹⁴²⁰) Meyer, *202*, **6**: 135; 82. (¹⁴²¹) Meyer, *9*, **13**: 494; 07. (¹⁴²²) Michael, *25*, **14**: 2105; 81. (¹⁴²³) Michaud, *135*, **53**: 232; 86. (¹⁴²⁴) Mills and

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- (1720) Pringsheim and Goldstein, 25, 56: 1520; 23. (1721) Pringsheim and Langhans, 25, 45: 2533; 12. (1722) Pryde, 4, 123: 1808; 23. (1723) Pschorr, 25, 45: 2212; 12. (1724) Pschorr and Dickhäuser, 25, 44: 2633; 11. (1725) Pschorr and Dickhäuser, 25, 45: 1567; 12. (1726) Pschorr, Jaekel and Fecht, 25, 35: 4377; 02. (1727) Pum, 57, 13: 676; 92. (1728) Purdie, 4, 63: 1143; 93. (1729) Purdie and Barbour, 4, 79: 971; 01.
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- (1850) Ryan and Ehrill, Sci. Proc. Roy. Irish Acad., 24B: 379; 03. (1851) Ryan, and Fitzgerald, Ibid, 30B: 106; 13. (1852) Sabatier and Murat, 34, 156: 184; 13. (1853) Saillard, Wehrung and Ruby, Mon. sci. Quesneville, 5: 4, 236. 10, 4: 584; 21. (1854) Salomon, 52, 28: 82; 83. (1855) Salway, 4, 99: 2148; 11. (1856) Salway, 4, 101: 978; 12. (1857) Salway, 4, 103: 1022; 13. (1858) Sandelin, 13, 396: 285; 12. (1858.5) Schardinger, 57, 11: 551; 90. (1859) Scheermesser, 202, 41: 68; 04.
- (1860) Scheihler, 25, 1: 108; 68. (1861) Scheihler, 25, 13: 2212; 80. (1862) Scheibler, 25, 17: 125; 84. (1862.5) Scheibler, 25, 17: 1729; 84. (1863) Scheibler, 25, 18: 1779; 85. (1864) Scheibler, 25, 45: 2272; 12. (1865) Scheibler and Mittelmeier, 25, 23: 1438; 90. (1866) Scheibler and Mittelmeier, 25, 26: 1331; 93. (1867) Scheibler and Wheeler, 25, 44: 2684; 11. (1868) Scheuer, 7, 72: 513; 10. (1869) Schiff, 13, 166: 94; 73.
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- (1890) Scholtz, 293, 251: 136; 13. (1891) Scholtz, Thesis, Zürich, 1914. 10, 4: 1092; 21. (1892) Scholtz and Muller, 25, 33: 2842; 00. (1893) Scholtz and Pawlicki, 25, 38: 1289; 05. (1894) Schoorl, 64P, 3: 459; 01. (1895) Schryver and Lees, 4, 77: 1024; 00. (1896) Schryver and Lees, 4, 79: 563; 01. (1897) Schütt, 25, 21: 2586; 88. (1898) Schultze, 25, 25: 2213; 92. (1899) Schultze, 202, 29: 467; 00.
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- (1920) Semmler, 25, 40: 5017; 07. (1921) Semmler, 25, 41: 1488; 08. (1922) Semmler and Bartelt, 25, 39: 3690; 06. (1923) Semmler and Bartelt, 25, 40: 432; 07. (1924) Semmler and Bartelt, 25, 40: 1363; 07. (1925) Semmler and Bartelt, 25, 40: 3101; 07. (1926) Semmler and Becker, 25, 46: 1814; 13. (1927) Semmler and Hoffmann, 25, 40: 3521; 07. (1928) Semmler and Mayer, 25, 44: 3657; 11. (1929) Semmler and Mayer, 25, 45: 786; 12.
- (1930) Semmler and Mayer, 25, 45: 1384; 12. (1931) Semmler and Rimpel, 25, 39: 2582; 06. (1932) Semmler and Risse, 25, 45: 3301; 12. (1933) Semmler and Risse, 25, 45: 3725; 12. (1934) Semmler and Risse, 25, 46: 599; 13. (1935) Semmler and Risse, 25, 46: 2303; 13. (1936) Semmler, Risse and Schröter, 25, 45: 2347; 12. (1937) Semmler and Rosenburg, 25, 46: 768; 13. (1938) Semmler and Schröter, 25, 45: 2347; 12. (1939) Semmler and Spornitz, 25, 46: 3700; 13.

- (1940) Semmler and Spornitz, *25*, **46**: 4025; 13. (1941) Semmler and Spornitz, *25*, **47**: 1029; 14. (1942) Semmler and Tobias, *25*, **46**: 2026; 13. (1943) Senter and Drew, *4*, **109**: 1091; 16. (1944) Sera, *202*, **88**: 460; 13. (1945) Sherry, *50*, **11**: 559; 07. (1946) Shinn, *50*, **11**: 201; 07. (1947) Sieker and Kremers, *11*, **14**: 291; 92. (1948) Sielisch, *13*, **391**: 1; 12. (1949) Simonsen, *4*, **123**: 2642; 23.
- (1950) Singh, *4*, **103**: 604; 13. (1951) Singh, *4*, **105**: 1972; 14. (1952) Singh and Mazumder, *4*, **115**: 566; 19. (1953) Singh and Singh, *4*, **117**: 1599; 20. (1954) Singh, Singh, Dutt and Singh, *4*, **117**: 980; 20. (1955) Singh, Singh and Lal, *4*, **119**: 1971; 21. (1956) Skinner, *1*, **45**: 1498; 23. (1957) Skita and Brunner, *25*, **49**: 1597; 16. (1958) Skraup, *13*, **199**: 344; 79. (1959) Skraup, *57*, **10**: 39; 89.
- (1960) Skraup, *57*, **25**: 633; 04. (1961) Skraup, *57*, **26**: 1415; 05. (1962) Skraup and Kremann, *57*, **22**: 1037; 01. (1963) Skraup and Vortmann, *13*, **197**: 226; 79. (1964) Skraup and Würstl, *57*, **10**: 220; 89. (1965) Skraup and Zwerger, *57*, **23**: 455; 02. (1966) Slavinskii, *53*, **29**: 118; 97. (1967) Smiles, *4*, **77**: 1174; 00. (1968) Smiles and Hilditch, *4*, **91**: 519; 07. (1969) Smirnov, *53*, **40**: 150; 08.
- (1970) Smirnov, *37*, **3**: 177; 20. (1971) Smith, *13*, **272**: 182; 93. (1972) Snape, *4*, **77**: 778; 00. (1973) Snape, *182*, **30**: 151; 14. (1974) Sohst and Tollens, *13*, **245**: 1; 88. (1975) Sonnenthal, *75*, **100 IIb**: 570; 91. (1976) Sorokin, *52*, **37**: 291; 88. (1977) Späth, Mosettig and Tröthandl, *25*, **56**: 875; 23. (1978) Speranskii, *53*, **34**: 10; 02. (1979) Spitzer, *25*, **11**: 1818; 78.
- (1980) Spitzer, *13*, **197**: 126; 79. (1981) Stadnikov, *53*, **36**: 485; 04. (1982) Steele, *182*, **27**: 240; 11. (1983) Steiger, *25*, **19**: 827; 86. (1984) Steiger, *202*, **11**: 375; 87. (1985) Stenberg, *7*, **70**: 534; 10. (1986) Stenberg, *Thesis*, Lund, 1916. (1987) Stoemer, *25*, **56**: 1683; 23. (1988) Stohmann and Langbein, *52*, **45**: 305; 92. (1989) Stubbs, *4*, **99**: 2265; 11.
- (1990) Stumpf, *8*, **37**: 351; 12. (1991) Svanberg, *25*, **56**: 2195; 23. (1992) Svanberg, *19*, **8**: No. 25; 23. (1993) Svanberg and Sjöberg, *25*, **56**: 1448; 23. (1994) Syniewski, *13*, **324**: 212; 02. (1995) Tafel, *13*, **268**: 229; 92. (1996) Tafel and Bubltz, *25*, **38**: 3806; 05. (1997) Tafel and Eckstein, *25*, **34**: 3274; 01. (1998) Tanret, *27*, **49**: 20; 88. (1999) Tanret, *34*, **109**: 908; 89.
- (2000) Tanret, *6*, **20**: 289; 90. (2001) Tanret, *34*, **122**: 86; 96. (2002) Tanret, *27*, **27**: 947; 02. (2003) Tanret, *34*, **147**: 75; 08. (2004) Tanret and Tanret, *34*, **129**: 725; 99. (2005) Tanret and Tanret, *27*, **21**: 1073; 99. (2006) Tattersall, *4*, **85**: 169; 04. (2007) Tattersall and Kipping, *4*, **83**: 918; 03. (2007.5) Taylor, *4*, **101**: 1124; 12. (2008) Thierfelder, *202*, **11**: 388; 87. (2009) Thierfelder, *202*, **15**: 71; 91.
- (2010) Thierfelder, *202*, **85**: 35; 13. (2011) Thomas, *4*, **101**: 725; 12. (2012) Thomas and Jones, *201*, **13**: 33; 05. (2013) Thomas and Jones, *4*, **89**: 280; 06. (2014) Thomé, *25*, **36**: 582; 03. (2014.5) Tommasi, *Thesis*, Zürich, 1920. *10*, **5**: 727; 25. (2015) Thoms, *344*, **19**: 771; 04. (2016) Thoms and Beckstroem, *25*, **35**: 3195; 02. (2017) Thoms and Vogelsang, *13*, **357**: 145; 07. (2018) Thomsen, *25*, **15**: 441; 82. (2019) Thomsen, *52*, **32**: 211; 89.
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- (2040) Traube, *94*, **22**: 47; 94. (2041) Trautenberg, *53*, **44**: 132; 12. (2042) Tsakalatos and Papaconstantinou, *49*, **14**: 97; 16. (2043) Tupizina, *Thesis*, Zürich, 1915. *10*, **4**: 584; 21. (2044) Tutin, *4*, **89**: 1104; 06. (2045) Tutin, *4*, **91**: 271; 07. (2046) Tutin, *4*, **91**: 275; 07. (2047) Tutin, *4*, **95**: 663; 09. (2048) Tutin, *4*, **97**: 1793; 10. (2049) Tutin, *4*, **103**: 2006; 13.
- (2050) Tutin, *4*, **107**: 7; 15. (2051) Tutin and Clewer, *4*, **101**: 2221; 12. (2052) Tutin and Naunton, *4*, **103**: 2050; 13. (2053) Tykociner, *70*, **1**: 144; 82. (2054) Ulpiani, *22*, **10 I**: 368; 01. (2055) Umney, *517*, **3**: 212; 12. (2056) Umney, *517*, **7**: 46; 16. (2057) Upson, *11*, **45**: 458; 11. (2058) Vahlen, *202*, **21**: 253; 95. (2059) Valasek, *2*, **20**: 639; 22.
- (2060) Valente, *36*, **11**: 196; 81. (2061) Valeur, *34*, **147**: 127; 08. (2062) Vavon, *34*, **152**: 1675; 11. (2063) Vavon, *34*, **153**: 68; 11. (2063.5) Vavon, *27*, **15**: 282; 14. (2064) Vedeneeva, *8*, **72**: 122; 23. (2065) Veneziani, *22*, **22 II**: 155; 13. (2066) Vernet, *34*, **92**: 360; 81. (2067) Vesterberg, *25*, **20**: 1242; 87. (2068) Vesterberg, *25*, **23**: 3186; 90. (2069) Vesterberg, *25*, **24**: 3834; 91.
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The following index contains the names of the simpler chemical compounds and the "common" names of the more complicated compounds, in so far as such common names exist. Complicated compounds which are named only in terms of their chemical structure should be located from the system of arrangement as explained in the Introduction. In general, only the parent compound is indexed, since derivatives are almost always to be found in the same section.

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COMMERCIAL EXPLOSIVES

WILLIAM RINTOUL AND GODFREY ROTTER

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ABBREVIATIONS

DNT	Dinitrotoluene.	N/G	Nitroglycerin.
MNN	Mononitronaphthalene.	TNN	Trinitronaphthalene.
N/B	Aromatic nitro body.	TNT	Trinitrotoluene.

INTRODUCTION

Pure compounds are not used to any great extent in civil applications of explosives. Ordinary commercial blasting and propulsive explosives have usually an empirical composition, with fairly wide tolerances for the proportions of the several ingredients, and very often one or more of these constituents is a substance of indefinite chemical composition. Furthermore the treatment during the process of manufacture, for example the fineness of the ingredients used, the time of mixing, and the physical condition of the product, have considerable influence on the properties of the finished explosive.

Data are tabulated relating to the principal explosive properties of the chief pure explosive substances, but for compounded explosives only typical or limiting compositions and properties are given.

TYPES OF TESTS

The principal tests used for explosives are described briefly below:

1. *Calorimetric tests* to determine the *heat of explosion* and the *volume and composition of the explosion gases*. For descriptions of the method of carrying out the experiments, see Vol. II, p. 440-444 of (25) and (39, 40).

The explosion temperature has not been determined directly, but can in principle be calculated from the pressure developed when the substance is exploded in a closed vessel. Various types of apparatus for determining the maximum pressures developed, or for recording variations in pressure, are described in (25). Explosion temperatures may also be calculated from the heat of explosion if the nature, amounts and specific heats of the explosion products are known.

2. *Trauzl Lead-block Test*.—This test is used for blasting explosives¹ as a ready means of estimating the relative powers of explosives of the same class fired under slight confinement. At the Berlin meeting (1903) of the International Congress of Applied Chemistry, standard conditions for carrying out this test were prescribed (2). Kast (19) gives a table of corrections for temperature.

3. The *fall-hammer test* is used to measure approximately the sensitiveness to shock of an explosive. The classification of explosives for transport on the German railways is based, in part, on the results of this test. The method of carrying it out is described in (14, 15), and by Marshall (25), Vol. II, p. 423.

¹ In the U. S. A. the ballistic mortar test described under 9, below, is largely used by manufacturers of explosives.

4. The *deflagration test* for the determination of the explosion temperature serves to measure the sensitiveness of the explosive to active decomposition by the action of heat.

5. A large number of so-called "stability tests" have been developed in order to obtain some idea of the chemical stability of explosives during storage. Among these may be mentioned the *Abel*, *Bergmann-Junk*, *Will* and *Sy* tests.

6. The *bulk density* of an explosive is an important factor in its behavior and this property can be varied within fairly wide limits by modifications in the method of manufacture.

7. The *detonation velocity* of an explosive is one of the most important factors in its brisance, and, therefore, in its practical applications. The methods used for measuring it are described in the textbooks; see, for example (25) Vol. II, p. 476. A discussion by Kast of the sources of error when the Siemens spark chronograph is used is largely applicable to any chronographic method (17).

The value found depends on the diameter of the train of explosive used (up to a certain limiting value, varying with the nature of the explosive); on the degree of confinement to which it is subjected; and on the method of initiation.

The detonation velocity increases in general with the density. In the case of certain explosives this increase continues up to a certain critical density, after which it falls rapidly. In the case of some of the less porous nitro bodies it has not yet been proved that the detonation value does decrease in this way after a certain limit, although there are indications that this is probably so.

Nitroglycerin gelatinous explosives have two distinct detonation velocities. That which is attained depends on various factors, but especially on the nature of the initiation and on the degree of confinement.

The following tests are of special importance in connection with coal mine explosives:

8. *Tests in an experimental gallery* to determine the maximum charge which can be fired without igniting an air-gas mixture containing specified proportions of an inflammable gas or coal dust or both. Natural firedamp, artificially prepared methane and illuminating gas have been used as the inflammable gas. A brief historical sketch of the various gallery tests is given in (13). A table appended to that pamphlet gives data regarding the principal testing galleries. On the basis of these tests limiting charges of explosive are fixed for use in mines.

9. *Ballistic pendulum tests* are used in Great Britain and the United States to furnish a comparative estimate of the strength of the explosive, the results being published as a guide to the purchaser in the selection of an explosive suitable for his requirements.

In the United States the detonation velocity of permissible coal mine explosives is also published, but this is not done for the British "permitted" explosives.

10. For propulsive explosives, tests are carried out in appropriate weapons to measure the *pressure developed in the barrel of the gun*, usually by means of crusher gages, and to determine the *velocity of the projectile*, and, for shotgun cartridges, the *shot "pattern."*

Velocities are measured over a certain distance from the muzzle of the gun by the use of a suitable target in conjunction with a chronograph. The result may be given as the average velocity over this distance or as the "remaining velocity" at half the distance, or a calculated value of the "muzzle velocity" may be reported. V_x is used to denote the remaining velocity at x meters (or other unit) found by means of a target placed at $2x$ meters from the gun.

11. For initiating explosives, in addition to the heat of explosion, the explosion point and the result of the fall-hammer test, there may also be given the result of a test similar to the Trauzl lead-block test but using a smaller lead block; of the "lead plate" test (which, however, does not furnish definite numerical results); of tests on the *limiting charge* required to initiate the detonation of a definite quantity of some explosive (usually a nitro body); of the *Esop* and *Wöhler tests* in which an explosive is phlegmatized in some manner until it is just no longer "initiated" by the initiator under test; or of the "sand" test developed by the U. S. A. Bureau of Mines, in which a detonating charge is exploded in the center of graded sand, and the degree of pulverization of the sand produced by the explosion is measured.

SIMPLE EXPLOSIVES (PURE SUBSTANCES)

Heat of Explosion

Explosion in calorimetric bomb. The heat of explosion may also be calculated from thermochemical data (*q.v.*, Vol. V, p. 162, 169), the results agreeing well with the experimental. Alternative methods of decomposition may be possible and the heat of explosion may thus vary, for example, with the loading density or the nature of the initiation.

Abbreviations

(g), Gaseous; (l) liquid; d, density; L.d., loading density.

Conversion Factors

1 g-cal₁₅/g = 4.185 joule/g = 1.800 BTU₆₀/lb.

Substance	Heat of explosion, g-cal ₁₅ per gram	Notes	Lit.
Ammonium nitrate..... 2NH ₄ NO ₃ = 2N ₂ + 4H ₂ O + O ₂ (requires strong detonator)	630 350	H ₂ O(l) H ₂ O(g)	(32, 37) (1, 6)
2NH ₄ NO ₃ = N ₂ + 4H ₂ O + 2NO..... NH ₄ NO ₃ = N ₂ O + 2H ₂ O.....	115 127.5	H ₂ O(g) H ₂ O(g)	(1, 6) (1, 6)
Cyanuric triazide.....	1140		(21)
Guncotton, 13%N.....	982	H ₂ O(g); L.d., 1.3	(30)
	1100	H ₂ O(l)	(32, 37)
12%N.....	730	H ₂ O(l)	(32, 37)
Lead azide.....	364 360 260		(26) (6) (21)
Lead trinitroresorcinate.	205(?)	Pb(g)	(21)
Mannitol hexanitrate....	1454, 1520	Pb(g)	(21)
Mercury azide.....	266		(20, 37)
Mercury fulminate.....	410 431 368		(26) (37, 38) (21)
<i>m</i> -Dinitrobenzene.....	820	Hg(l) Hg(g) H ₂ O(g); L.d., 1.3	(21) (21) (30)
Nitroglycerin.....	1478	H ₂ O(g);	(30)
	1550 to 1590		(5, 29, 37)
Picric acid.....	717 840 914	H ₂ O(g) H ₂ O(l) H ₂ O(g); L.d., 1.3	(3) (32) (30)
	809	Mean for various L.ds.	(12)

Heat of Explosion.—(Continued)

Substance	Heat of explosion, g-cal ₁₅ per gram	Notes	Lit.
Silver fulminate.....	470		(26)
Tetranitromethylaniline (tetryl).....	1090	H ₂ O(g); L.d., 1.3	(30); cf. (10)
Trinitrobenzene.....	940	H ₂ O(g); L.d., 1.3	(30)
Trinitrotoluene.....	880 924 881 to 892	H ₂ O(l) H ₂ O(g); L.d., 1.3 L.d., 0.2; d, 1.45	(32) (30) (12)

Trauzl Lead-Block Test

Explosive	Expansion, cm ³	Lit.
Ammonium nitrate.....	142* 103† 165 198	(49) (49) (19, 27)
Ammonium chlorate.....	240	(19, 28)
Ammonium perchlorate.....	140 193	(19) (27)
Dinitrobenzene.....	250	(19)
Dinitroglycerin (gelatinized).....	330	(5)
Guncotton.....	360† 375	(3) (19)
Dry, compressed, 12.77 %N.....	317†	(47)
Dry, compressed, 13.18 %N.....	352† 290	(47) (10)
With 13 %N.....	420§	(6)
Wet.....	280	(19)
With 20 % water.....	280	(32)
Hexanitrodiphenylamine.....	320 352	(19) (33)
Hexanitrophenyl sulfide.....	355	(33)
Hydrazine nitrate (basic).....	362*	(50)
Nitroglycerin.....	515 600 600§ 550 590	(19) (32) (6) (28) (28)
Nitromannite.....	650§	(6)
Nitropentaerythritol.....	460	(32)
Nitrostarch.....	305	(33)
Picric acid.....	302¶ 292*†† 330 297 287	(44) (47) (33) (10) (45)
Acid as powder.....	301*	(45)
Acid cast.....	264*	(45)
Acid compressed.....	292* 305	(45) (32)
Tetranitroaniline.....	400† 415 430	(50) (33) (10)
Tetranitroanisole.....	390	(32)
Tetryl (Powder).....	357**	(46)
(Cast).....	322†**	(46)

Trauzl Lead-Block Test.—(Continued)

Explosive	Expansion, cm ³	Lit.
Tetryl.—(Cont'd)		
(Pressed).....	322†**††	(46)
	340	(19)
	375	(33)
	375	(10)
	369†	(50)
	374†	(49)
	348	(48)
Trinitroanisole.....	290	(19)
	322	(33)
Trinitrobenzene.....	330	(19)
	364	(33)
Trinitrochlorobenzene.....	295	(19)
	322	(33)
Trinitrocresol.....	275	(19)
	301	(33)
Trinitrotoluene.....	300†	(3)
	285	(19)
	274	(33)
	254	(10)
	238	(48)
	260§	(6)
Mean of 25 results.....	249	(7.5)
Commercial (Powder).....	289***	(46)
(Cast).....	102***	(46)
(Pressed).....	54**††	(46)
(Powder).....	280††	(46)
(Cast).....	208††	(46)
(Pressed).....	255††††	(46)

* Volume of borehole, 63 cm³, deducted.† With picric acid as primer, 297 cm³ deducted for primer, 63 cm³ for original volume of borehole.

‡ Volume of borehole deducted.

§ After deducting 61 cm³ for borehole and 17 cm³ for No. 8 detonator.

|| Liquid N/G with sand tamping.

¶ Acid finely crystalline.

** No. 8 detonator.

†† Pressed at 1246 kg per cm.²

††† No. 8 tetryl detonator.

Lead-Block Test (Initiating Explosives) (21)

In testing initiating explosives a smaller lead block is used, 80 mm in diameter and 80 (or 100) mm high with a charge of 2 g of the substance

Explosive	Expansion, cm ³	d*
Cyanuric triazide.....	131.3	1.2
Lead azide.....	26	2
Lead trinitroresorcinate.....	29	1.8
Mercury fulminate.....	33	1.7

* d = density of explosive, g/cm³.

Fall-Hammer Test
Results for 2 kg hammer

Explosive	Fall in cm	Lit.
Ammonium picrate.....	80	(36)
Copper picrate.....	7	(36)
Dinitrobenzene.....	>60	(16)
	150	(16)

Fall-Hammer Test.—(Continued)

Explosive	Fall in cm	Lit.
Dinitroglycerin.....	7	(36)
Moist.....	30	(42)
Dinitrophenol.....	150	(36)
Guncotton compressed, 15% H ₂ O.....	85	(36)
20% H ₂ O.....	>180	(36)
Dry.....	17 to 18	(41)
+20% H ₂ O.....	>183*	(41)
+35% H ₂ O.....	>183	(41)
Hexanitrodiphenylamine.....	40	(36)
Iron picrate.....	7	(36)
Lead picrate.....	5	(36)
Nitrocotton (collodion cotton), compressed,		
15% H ₂ O.....	100	(36)
20% H ₂ O.....	>180	(36)
Dry.....	36	(41)
+20% H ₂ O.....	>183*	(41)
+35% H ₂ O.....	>183	(41)
Nitroglycerin, dry.....	4	(36)
Moist.....	4	(42)
Liquid.....	10†	(43)
Frozen.....	38 to 40†	(43)
Picric acid (finely crystalline).....	35 to 95	‡
Silver picrate.....	5	(36)
Sodium picrate.....	80	(36)
Tetryl.....	40 to 65	(36)
	30	(32)
Trinitroanisole.....	>60	(16)
Trinitrobenzene.....	40 to 50	(36)
Trinitrocresol.....	30	(36)
Trinitrodimethylaniline.....	95	(36)
Trinitronaphthalene.....	175	(36)
Trinitrotoluene.....	57-90 and up to 180	‡
Zinc picrate.....	60	(36)

* Partly caked residue.

† For 1 kg hammer.

‡ Various sources.

Explosive	Weight of explo- sive, g	Weight of ham- mer, g	Fall in cm	Lit.
Azides, Ba.....	0.02	599	14	(26)
Cd.....	0.02	964	27.5	(26)
Cu.....	0.01	599	9.5	(26)
	0.02	599	10.5	(26)
	0.03	599	13.0	(26)
	0.05	599	24.0	(26)
Pb.....	0.01	599	17	(26)
	0.02	599	17	(26)
	0.05	599	14.5	(26)
Hg.....	0.01	599	17	(26)
	0.02	599	16.5	(26)
	0.05	599	14	(26)
Ag.....	0.05	964	18	(26)
Na.....	0.05	820	>30	(22)
Fulminates, Hg.....	0.05	500	7.5	(22)
		2000	2	(9)
Na.....	0.05	620	30	(22)

Limiting Charges Necessary for Various Initiating Explosives

Initiating explosive A	Explosive B against which tested	Amount of explosive B, g	Limiting charge of explosive A required for detonation of B, g	Lit.
Lead azide*.....	Tetryl	0.5	0.025	(26)
	Picric acid	0.5	0.025	(26)
	TNT	0.5	0.09	(26)
	Trinitroanisole	0.5	0.28	(26)
Mercury fulminate†.....	Picric acid	1	0.25	(38)
	TNT	1	0.30	(38)
	TNT	0.5	0.25	(22)
	Tetryl	0.4	0.35‡	(34)
	Tetranitroaniline	0.4	0.45	(34)
	Picric acid	0.4	0.40§	(34)
	TNT	0.4	0.26	(34)
	Picric acid	0.5	0.30	(26)
	Tetryl	0.5	0.29	(26)
	TNT	0.5	0.36	(26)
	Trinitroanisole	0.5	0.37	(26)
	Trinitroxylylene	0.5	0.43	(26)
	TNT		0.26¶	(35)
			0.30**	(35)
	Tetryl		0.24¶	(35)
			0.25**	(35)
	Guncotton	0.5	0.20††	(38)
	Picric acid	1.0	0.25 to 30††	(38)
	Trinitroresorcinol	1.0	0.20††	(38)
	Trinitrocresol	1.0	0.30††	(38)
	Trinitrobenzoic acid	1.0	0.25††	(38)
	Trinitrobenzene	1.0	0.25††	(38)
	TNT	1.0	0.30††	(38)
	Trinitroxylylene	1.0	0.40††	(38)
Mercury fulminate +0.01g lead azide..	TNT	0.5	0.02	(22)
Mercury fulminate +20% lead azide..	TNT		0.18¶	(35)
			0.06¶	(35)
	Tetryl		0.06**	(35)
Mercury fulminate-potassium chlorate mixture, 90:10.....	Tetryl	0.4	0.3000	(34)
	Tetranitroaniline	0.4	0.3125	(34)
	Picric acid	0.4	0.3750††	(34)
	TNT	0.4	0.2500	(34)
80:20.....	Tetryl	0.4	0.2750	(34)
	Tetranitroaniline	0.4	0.3125	(34)
	Picric acid	0.4	0.3750§§	(34)
	TNT	0.4	0.2400	(34)
Silver azide.....	Guncotton	0	0.05††	(38)
	Picric acid	1	0.025††	(38)
	Trinitroresorcinol	1	0.08††	(38)
	Trinitrocresol	1	0.05††	(38)
	Trinitrobenzoic acid	1	0.10 to 0.20††	(38)
	Trinitrobenzene	1	0.05††	(38)

Limiting Charges Necessary for Various Initiating Explosives.—
(Continued)

Initiating explosive A	Explosive B against which tested	Amount of explosive B, g	Limiting charge of explosive A required for detonation of B, g	Lit.
Silver azide.— (Cont'd).....	TNT	1	0.05††	(38)
Silver fulminate.	Trinitroxylylene	1	0.25††	(38)
	Tetryl	0.5	0.02	(26)
	Picric acid	0.5	0.05	(26)
	TNT	0.5	0.10	(26)
	Trinitroanisole	0.5	0.23	(26)
	Trinitroxylylene	0.5	0.30	(26)

* The Rheinische-Westfälische Sprengstoff A. G. say that lead azide detonates satisfactorily with as much as 5 % of water.

† The Rheinische-Westfälische Sprengstoff A. G. say that pure fulminate and its mixtures do not detonate satisfactorily when containing 1 % water.

‡ 0.24 in reinforced detonator.

§ 0.25 in reinforced detonator.

|| In reinforced detonator.

¶ At 200 atm.

** At 400 atm.

†† Pressure 2000 kg/cm².

‡‡ 0.2300 in reinforced detonator.

§§ 0.2200 in reinforced detonator.

Detonation Velocity

Name	Det. vel., km/sec, V	Δ,* g/cm ³	D,† mm	Notes	Lit.
Ammonium nitrate.....	1.46	0.83	25	1, 2	(20)
	1.31	0.84	25	1, 2	(20)
	1.47	0.83	26	1, 3	(20)
	1.23	0.69	50	1, 4	(20)
	1.25	0.65	50	1, 4	(20)
	1.49	0.68	80	1, 4	(20)
	1.50	0.66	80	1, 5	(20)
	1.53	0.79	80	1, 4	(20)
	1.55	0.88	80	1, 4	(20)
	2.70	0.98	80	1, 6	(20)
Ammonium perchlorate...	1.92	0.64	100	1, 4	(20)
	1.83	0.84	100	1, 15	(20)
	2.57	1.17	35	1, 7	(20)
	2.47	1.17	35	1, 7	(20)
Hexanitrodiphenylamine..	2.48	1.0	38	1, 8	(20)
	7.10	1.58	21	9, 10	(17)
	7.15	1.67	21		
Mannitol hexanitrate.....	8.26	1.73	12.8	†	(20)
Mercury fulminate.....	3.00			Loose	(30)
	3.92		6.45		(4)
	2.25	1.25		Ordinary temp.	(23)
Nitroglycerin (in Mannesmann tube).....	2.35	1.25		—190°C	(23)
	8.00			liq.	(31)
	7.46	1.60	30		(19.5)
	1.53			liq.	(5)
	Det. not transmitted		6	11, 13 in 12	(7)
	0.65		9	13	(7)

Detonation Velocity.—(Continued)

Name	Det. vel., km/sec, V	Δ ,* g/cm ³	D,† mm	Notes	Lit.
Nitroglycerin.—(Cont'd) . .	1.45		25	13	(7)
	or		25	14	(7)
	7.69				
	8.53		38	1, 13	(7)
(0.8 g detonator.)	2.02		38		(7); cf. (7.5)
(Det. fuse as primer) . . .	7.23				
Picric acid	8.18	1.55	30		(3)
	7.25	1.63			(31)
	4.55	0.86			(14.5)
	6.16	1.34	21		(17)
	6.70	1.46	21		(17)
	7.00	1.53	21		(17)
	7.10	1.60	21		(17)
	7.26	1.69	21		(17)
	4.51	0.90	9.2		(8)
	5.10	0.94	20		(8)
	6.33	1.32	20		(8)
	6.94	1.46	20		(8)
	7.10	1.50	20		(8)
	7.37	1.62	20		(8)
	7.14	1.67	20		(8)
	7.49	1.72	20		(8)
In paper case	5.35	1.20	40		(11)
	5.71	1.40	40		(11)
	6.87	1.60	40		(11)
In Mannesmann tube . . .	4.63	0.85	40		(11)
	5.21	1.20	40		(11)
Tetryl	7.15	1.53	21		(17, 18)
	7.16	1.59	21		(17, 18)
	7.20	1.63	21		(17, 18)
	7.25	1.63			(31)
Trinitrobenzene	6.27	1.33	21		(17, 18)
	6.30	1.35	21		(17, 18)
	6.94	1.56	21		(17, 18)
	7.00	1.60	21		(17, 18)
	7.00	1.64			(17, 18)
(Using various detonators and various amounts of dynamite as primer)	7.06	1.62			(8)
	7.35	1.64			(8)
	7.28	1.65			(8)
	7.35	1.66			(8)
	7.07	1.65			(8)
	7.00	1.53			(8)
	3.97	0.75	20		(8)
	3.81	0.62	20		(8)
	5.16	0.97	20		(8)
Trinitrochlorobenzene . . .	6.80	1.66	21		(17)
(Pressed)	6.86	1.71	21		(17)
(Pressed)	7.13	1.75	21		(17)
(Cast)	7.15	1.76	29		(17)
Trinitroresol	6.62	1.52	21		(17)
	6.85	1.62	21		(17)
Trinitrophenol	7.25	1.63			(30)
Trinitrophenylmethyl-nitroamine	7.52	1.63			

Detonation Velocity.—(Continued)

Name	Det. vel., km/sec, V	Δ ,* g/cm ³	D,† mm	Notes	Lit.
Trinitrotoluene, paper covers	4.05	0.79	40		(11)
	5.24	1.22	40		(11)
	6.38	1.45	40		(11)
	6.87	1.59	40		(11)
	4.74	0.85	40		(11)
In Mannesmann tube . . .	5.40	1.22	40		(11)
	6.29	1.45	40		(11)
	6.77	1.59	40		(11)
Various conditions of confinement	6.46	1.47	21		(17)
	6.70	1.59	29		(17)
	6.69	1.59	160		(17)
	6.22	1.32	20		(8)
	6.68	1.46	20		(8)
	6.88	1.56	20		(8)
	7.06	1.59	20		(8)
	7.14	1.60	20		(8)
	6.94	1.61	20		(8)
Trinitroxylenes	6.60	1.51			(30)

* Bulk density in cartridge form.

† Cartridge or tube diam., mm.

‡ Free lying cartridge.

NOTES

1. In wrought iron tube.
2. Primer 50 g pressed tetryl.
3. Primer 60 g pressed tetryl.
4. Primer 100 g pressed picric acid.
5. Primer 300 g pressed picric acid.
6. Primer 250 g pressed tetryl.
7. Primer 110 g pressed tetryl.
8. Primer 25 g pressed picric acid.
9. 10 g picric acid and 1 g detonator.
10. Tamped with sand.
11. Glass tube.
12. Larger tube attached.
13. 1.6 g detonator.
14. Sheet iron tube.
15. Primer 200 g pressed tetryl.

COMPOUNDED EXPLOSIVES

BLASTING EXPLOSIVES

The following classification of blasting explosives will be found useful, though the classes are by no means mutually exclusive.

A. Non-detonating explosives. B. Detonating or high explosives.

A. *Non-detonating explosives.*

Black powder is the principal type of this class. The German "Sprengsalpeter" is similar to black powder, with sodium nitrate in place of potassium nitrate.

B. *Detonating or high explosives.*

I. Nitroglycerin explosives.

(a) Gelatinous explosives.

(b) Dynamites.

(1) With inactive additions.

(2) With active additions.

II. Ammonium nitrate explosives containing as sensitizer:

(a) Nitroglycerin.

(b) Aromatic nitro body.

(c) Non-explosive substance.

III. Perchlorate explosives.

IV. Chlorate explosives.

Nitroglycerin explosives are liable to freeze and their use in the frozen condition gives rise to danger. This danger may be removed by partially or wholly replacing the nitroglycerin by

nitrate chlorohydrin, ethyleneglycol dinitrate, dinitroglycerin, nitrated polyglycerin or aromatic nitro compounds such as nitrobenzene, thus forming low freezing (L. F.) explosives.

Some dynamites have a certain proportion of nitrocotton incorporated with the nitroglycerin to diminish the risk of exudation of the nitroglycerin during transport or storage. These may be called semi-gelatins. They resemble the dynamites rather than the gelatins in properties.

A special class of blasting explosives is constituted by those officially authorized for use in coal mines, which are often referred to as "safety explosives." They are known as "permitted explosives" in Great Britain, "permissible explosives" in the United States, "Wettersprengstoffe" in Germany, "Explosifs S. G. P., in Belgium, and "explosifs de sûreté" in France. They usually contain alkaline salts, or sometimes hydrated salts, to reduce the temperature of detonation, and the length and duration of flame.

COMPOSITIONS OF VARIOUS TYPICAL COMPOUNDED EXPLOSIVES
Blasting Explosives (See p. 495 for properties)

Key number	Explosive
1	Black Powder: KNO_3 , 62–75.7%; S, 10–19.4%; charcoal, 12–5%. The properties can be modified to a considerable extent by varying the nature of the charcoal used, the time of mixing and the size of grain of the product.
2	Bobbinite: KNO_3 , 65.31%; S, 2.63%; charcoal, 19.52%; paraffin, 3.35%; starch, 8.73%; H_2O , 0.46%.
3	Blasting Gelatin: * Nitroglycerin, 90–95%; nitrocotton, 5–10%.
4	Nobel Gelatinous Explosives: * Nitroglycerin, 25–85%; nitrocotton, 0.5–7%; liquid nitro body, 0.4–9%; woodmeal, 0.9–10%; K or Na nitrate, 6–45%; chalk, 0–0.3%.
5	U. S. A. Gelatin Dynamites: * L. F. Nitroglycerin, 20–80%; nitrocotton, 0.3–4.5%; combustible substances, 6–16%; NaNO_3 , 1.5–6.2%; CaCO_3 , 1%.
6	French "Gommes": * Nitroglycerin, 49–86%; nitrocotton, 2–6%; woodmeal, 0.25–10%; KNO_3 , 4–36%.
7	Kieselguhr Dynamite: † Nitroglycerin, 72–75%; kieselguhr, 25–28%.
8	Nobel Glasgow Dynamites (Semigelatinous): Nitroglycerin, 24.4–57%; nitrocotton, 0.6–3.0%; NaNO_3 , 21–55.75%; woodmeal, 16.5–19.25%.
9	U. S. A. Straight Dynamites: L. F. Nitroglycerin, 15–75%; NaNO_3 , 5–66%; combustible substances, 5–20%; CaCO_3 or MgCO_3 , 1%.
10	Pittsburgh Standard 40% Straight Dynamite: Nitroglycerin, 40%; NaNO_3 , 44%; wood pulp, 15%; CaCO_3 , 1%.
11	Carbonites: Nitroglycerin, 17–30%; NaNO_3 , 24–30%; combustible (usually flour), 37–44%. Antacids are sometimes added, and the explosive may be made of the low freezing type by the use of tetranitrodiglycerin.
12	Carbonite Type of Explosive Tested by U. S. A. Bureau of Mines (Explosive D): Nitroglycerin, 24.92%; KNO_3 , 25.37%; $\text{Ba}(\text{NO}_3)_2$, 4.42%; woodmeal, 34.60%; starch, 6.64%; H_2O , 4.05%.
13	U. S. A. Ammonia Dynamites: NH_4NO_3 , 7–50%; NaNO_3 , 14–60%; nitroglycerin, 12–25%; combustible substances, 8–20%; CaCO_3 or ZnO , 1%.

* Camphor, soda or chalk have also been added in small proportions, and sometimes a little nitro body.

† Sometimes soda, talc or heavy spar is added in small proportions.

COMPOSITIONS OF VARIOUS TYPICAL COMPOUNDED EXPLOSIVES.—
(Continued)

Key number	Explosive
14A	Grisoudynamite Couche: NH_4NO_3 , 87.5% (or 82.5% + KNO_3 , 5%); nitroglycerin, 12%; nitrocotton, 0.5%.
14B	Grisoudynamite Roche: NH_4NO_3 , 70% (or 65% + KNO_3 , 5%); nitroglycerin, 29%; nitrocotton, 1%.
15	Donarit: NH_4NO_3 , 80%; nitroglycerin (gelatinized or not), 4%; TNT, 12%; rye flour, 4%.
16A	Grisounaphthalite Couche: NH_4NO_3 , 95% (or 90% + KNO_3 , 5%); trinitronaphthalene, 5%.
16B	Grisounaphthalite Roche: NH_4NO_3 , 91.5% (or 86.5% + KNO_3 , 5%); dinitronaphthalene, 12%.
17	Withnell Type of Explosive Tested by U. S. A. Bureau of Mines (Explosive J): NH_4NO_3 , 90.5%; TNT, 4.82%; flour, 4.23%; H_2O , 0.45%.
18	Yonckites (Belgium): NH_4ClO_4 , 6–25%; NH_4NO_3 , 17.5–65%; NaNO_3 , 27–30%; $\text{Ba}(\text{NO}_3)_2$, 6–10%; TNT, 10–22.5% or TNN, 3.75%.
19	Sabulex: NH_4NO_3 , 59–56%; KClO_4 , 8–10%; TNT, 9–7%; NH_4Cl , 26–24%.
20	Perchloratites (Germany): The perchloratites authorized for use in Prussia include explosives with contents of KClO_4 ranging from 30–75%.
21	Cheddites: KClO_3 , 70–90%; aromatic nitro compounds, 0–20%; paraffin, 0–14%.
22	Cheddite Type Explosive Tested by U. S. A. Bureau of Mines (Explosive E): KClO_3 , 75.36%; MN, 1.3%; DNT, 17.85%; castor oil, 5.32%; H_2O , 0.17%.
23	Silesia Type Explosive Tested by U. S. A. Bureau of Mines (Explosive F): KClO_3 , 75.27%; nitrated resin, 24.63%; H_2O , 0.10%.
24	Chloratites (Germany): The chloratites authorized for use in Prussia include explosives with contents of KClO_3 or NaClO_3 ranging from 70–91%, along with aromatic nitro derivatives and combustible substances.

Explosives For Use in Fiery Coal Mines

POWER

The power of British "permitted explosives" is measured by means of a ballistic pendulum test. A stemmed charge is fired electrically from a gun into a ballistic pendulum and the deflection is compared with that given by 4 oz. of 60% gelignite under the same conditions. The standard charge gives a swing of 3.27 in., and the actual deflections are reduced to correspond to this value.

The values will be found in the "*Explosives in Coal Mines Orders*."

The standard used in the United States is 40% straight dynamite. The unit deflective charge is that which gives the same deflection as 227 g ($\frac{1}{2}$ lb.) of the standard dynamite.

In Belgium a modified form of the Trauzl lead-block test is used for comparing the powers of S. G. P. explosives. The weight of explosive equivalent to 100 g of dynamite No. 1 is given. The values are published in the *Annales des Mines de Belgique*.

CHARGE LIMIT

For British "permitted" explosives the charge limits have in the past varied from 8 oz., to 40 oz., but are now fixed at the uniform figure of 28 oz. Results are published in the *Explosives in Coal Mines Orders*.

A general limit of $1\frac{1}{2}$ lbs. is fixed for the maximum permissible charge of the U. S. A. "permissible explosives," and no explosive is placed on the list unless this maximum charge satisfies the gallery test.

PROPERTIES OF VARIOUS TYPICAL COMPOUNDED EXPLOSIVES
Blasting explosives (See p. 494 for compositions)

Key number	Explosive	Heat of explosion, g-cal per g	Trauzl lead-block test, expansion in cm ³	Fall-hammer test, weight of hammer 2 kg; fall, cm	Detonation velocity, meters per second	Loading density, g/cm ³	Propagation of detonation by influence, cm	Diameter of cartridge, mm
1	Black powder.....	622-789 H ₂ O(l)	30	30-40	300-420 (rate of burning)	1.04-1.2		
2	Bobbinite*.....	623 H ₂ O(l)		>100	469	1.25		
3	Blasting gelatin.....	1530-1565 H ₂ O(g)	500-600	12-25	1500-2500 or 7200-8100	1.5-1.6 1.55-1.7		
4	Nobel gelatinous explosives.....		270-540		2300-5000 and up to 5000-9000			
5	U. S. A. gelatin dynamites.....				2100-2500 or 5000-7000			
7	Kieselguhr dynamite.....	1100-1300	300-370	7	1990-9700	Max., 1.67	30	32
9	U. S. A. straight dynamite.....	30%, 1025.8 60%, 1663.4	30% 190 60% 318		5%, 1294 60%, 5800-6000	20% 1.18		
10	Pittsburgh Standard 40% straight dynamite.....	1221.4	278	10	4688	1.22	43.2	32
11	Carbonites (U. S. A.).....	573-770	120-185	6-13	2285-3470	0.98-1.33	7.5-2.3	32
12	Carbonite type (Explosive D)*.....	570.7	156	13	2589	0.68	10.2	32
13	U. S. A. ammonia dynamites.....	40%, 1122	40%, 202		3010-4380 40%, 3157	40%, 1.57		
14A	Grisoudynamite couche.....	783					3.7	30
14B	Roche.....	978					8.2	30
	Roche sâlpêtrée.....	870						
15	Donarit.....	930-1220	375-400	30-160	3700-4150		2.7	30
16A	Grisounaphthalite couche.....				2460-3240 (according to diam. of cartridge)			
	Couche sâlpêtrée.....	816						
16B	Roche.....						3.9	30
17	Withnell type (explosive J)*.....	1285.5	245	100	3971	0.94	7.6	32
21	Cheddites.....	1065-1185	210-280	14-36	2100-3100 (according to density)	13-1.6		
22	Cheddite type (explosive E)*.....	1065.1	212	23	2771	1.28	7.6	32
23	Silesia type (explosive F)*.....	865.5	201	3	2722	1.04		

* Tested by U. S. A. Bureau of Mines.

The charge limits for Belgian S. G. P. explosives vary from 400 g to 900 g. The values are published in the *Annales des Mines de Belgique*.

The charge limits fixed in the Prussian official regulations for the use of "Wettersprengstoffe" are 700 or 800 g, separate limits being fixed for fiery and non-fiery mines. In the great majority of cases the limit is 800 g in each case. See "Das Sprengstoffwesen im preussischen Bergbau."

DETONATION VELOCITY

The detonation velocities of U. S. A. permissible explosives vary from 1792 meters per second for Red H.C. L.F. to 4651 for Gelobel.

Values are not published by the authorities in Great Britain. The detonation velocities of the permitted explosives made by Nobel Industries Limited range from 1900 to 5000 meters per second.

Propulsive Explosives

Propulsive explosives may be arranged under the following classes:

1. Black powder type.
2. Nitrocellulose powders.
 - (a) Without additions.
 - (b) With additions.

3. Nitroglycerin powders containing both nitrocellulose and nitroglycerin.

(a) Without other additions.

(b) With other additions.

Examples are given showing the composition and properties of various compounded explosives.

Black Powder, *see* Blasting Explosives.

Amide Powder (Chilworth Special Powder): NH_4NO_3 , 35.38%; KNO_3 , 40–46%; charcoal, 14–22%.

Ammonpulver: NH_4NO_3 , 80–90%; charcoal, 10–20%.

Nitrocellulose Powders

American Pyrocollodion Powders: nitrocellulose 99.4% (mixture of di- and trinitrocellulose, average nitrogen content 12.60%), diphenylamine. Together with residual solvent and water 0.6%.

French B Powder: CP_2 , 20–25% to 50–55% according to the liveliness of the powder, along with CP_1 . The solvent used is ether-alcohol. Amyl alcohol or diphenylamine may be used as stabilizer. These are indicated by AM or D after the name. CP_1 is a nitrocotton with nitrogen content of about 13%. About 10% (<15%) is soluble in ether-alcohol. It gives off 205–214 cm^3 of $\text{N}_2\text{O}_4/\text{g}$ in nitrometer test. CP_2 is a nitrocotton with nitrogen content of about 12%, almost completely soluble in ether-alcohol (>96%) and giving off 190–198 cm^3 of N_2O_4 per g in nitrometer.

Walsrode Shotgun Powder: Nitrocellulose, 97%; chalk, 2%; ether, 1%.

Nitrocellulose Powders with Additions

Amberite:* Nitrocellulose (insoluble, 18.6%, soluble, 46%); mineral nitrates, 2.8%; vaseline, 6%; H_2O , 1.4%.

Clermonite: Nitrocellulose with mineral nitrates.

E. C. Powder: Contains from 14% of mineral nitrates and vaseline, camphor, resin and woodmeal or some of them in addition to nitrocellulose.

Empire Powder: Contains mineral nitrates, 9%, and vaseline in addition to nitrocellulose.

Hasloch Jagdpulver: Contains $\text{Ba}(\text{NO}_3)_2$, 17%, and vaseline in addition to nitrocellulose.

J. Powder (French): Contains $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$, 14%, and $\text{K}_2\text{Cr}_2\text{O}_7$, 3%, in addition to nitrocellulose.

T. Powder (French): Contains 2% KNO_3 in addition to nitrocellulose, CP_1 gelatinized with acetone.

S. Powder:† CP_1 , 37%; CP_2 , 28%; $\text{Ba}(\text{NO}_3)_2$, 29%; KNO_3 , 6%.

Rottweil Smokeless Powder (Shotgun): Insoluble nitrocellulose, 72.3%; soluble nitrocellulose, 24.5%; camphor and diphenylamine, 1%; H_2O , 1.5%; metallic nitrates, 0.7%.

Rottweil Smokeless Powder (Rifle): Insoluble nitrocellulose, 72.8%; soluble nitrocellulose, 25.0%; camphor and diphenylamine, 1%; H_2O , 1.2%.

Nitroglycerin Powders

Ballistite:‡ Guncotton, 50%; nitroglycerin, 49%; diphenylamine, 1%.

Ballistite, Norwegian: Guncotton, 50%; nitroglycerin, 40%; nitronaphthalene, 5%; diamyl phthalate, 5%.

Sporting Ballistite: Nitrocellulose, 60.5%; nitroglycerin, 39.5%.

Cordite Mk. I: Guncotton, 37%; nitroglycerin, 58%; mineral jelly, 5%; H_2O , 0.5%.

Cordite M. D.: Guncotton, 65%; nitroglycerin, 30%; mineral jelly, 5%; H_2O , 0.5%.

Cordite R. D. B.: Nitrocotton ($\text{N} = 12.2\%$), 52%; nitroglycerin, 42%; mineral jelly, 6%.

* Fibrous 42% grain bulk.

† Partially gelatinized with ether-alcohol.

‡ Gelatinized with acetone.

Nitroglycerine Powders with Additions

Köln-Rottweil TNT powder: Nitrocellulose, 61%; nitroglycerin, 20%; TNT, 15%; DNT, 3.5%; centralite, 0.5%.

Allestitute: Nitrocellulose, 60%; nitroglycerin, 25%; DNT, 15%.

Austrian Flake Powder No. 1: Nitrocellulose, 36%; nitroglycerin, 36%; $\text{Ba}(\text{NO}_3)_2$, 18%; charcoal, 10%.

Austrian Flake Powder No. 2 (Graphited): Nitrocellulose, 40%; nitroglycerin, 40%; $\text{Ba}(\text{NO}_3)_2$, 20%.

Wetteren Smokeless Powder:* Nitrocellulose, insoluble, 16%, soluble, 46.2%; nitroglycerin, 27.3%; charcoal, 9%; H_2O , 1.5%.

In the application of propulsive explosives the nature of the weapon, the velocity of the projectile, and the maximum permissible pressure in the barrel are usually fixed, and the powder is modified in composition or physical properties to give the ballistics demanded.

The following table from an article by MacNab and Leighton (24) gives the heat of explosion and the volume and composition of the explosion gases for a number of sporting powders.

Properties of Some Sporting Powders (24)

Powder	Heat of explosion, g-cal/g	Permanent gases per g, cm^3	Water vapor per g, cm^3	Total volume of gas at 0°C and 760 mm, cm^3 per g	Composition of permanent gases, %				
					CO_2	CO	CH_4	H	N
Imperial Schultze.	742	763	152	915	8.9	52.7	1.0	27.0	10.4
Amberite.....	745	635	156	791	12.0	50.0	0.4	25.5	12.1
S. S.....	755	695	131	816	11.8	51.3	0.8	23.7	12.4
E. C.....	762	718	158	876	11.9	52.1	0.5	23.9	11.6
Schultze.....	786	576	160	736	15.5	46.7	0.8	23.0	14.0
Kynoch's smokeless.....	807	600	126	726	14.8	49.5	0.7	18.8	16.2
Cannonite.....	845	725	146	871	14.6	49.9	0.6	22.2	12.7
Shotgun Rifleite..	896	705	169	874	19.0	45.3	0.8	21.5	13.4
Walsrode.....	1014	669	206	875	21.3	48.2	0.4	10.1	14.8
Cordite M. D.....	1031	726	215	941	16.3	50.4	0.0	19.7	13.6
Cordite.....	1253	647	235	882	24.9	40.3	0.7	14.8	19.3
Sporting Ballistite.	1286	591	234	825	32.2	37.1	0.4	10.1	20.2

Standard Ballistics for Shotgun Powders

A. TYPICAL AMERICAN STANDARD PROOF

Lead crushers are used, the Eley 1913 tables being employed to calculate the pressures from the remaining length.

The following are the average ballistics aimed at for various typical powders. They refer to matured powder containing 1½% moisture.

Charges	Velocity over 40 yards = V_{20} yd. or $V_{18.3}$ M	Pressure at 1 in. (2.54 cm) from base
Smokeless Shotgun		
3 drams powder = about 5.30 g. 1½ oz. = 31.89 g shot. 2½ in. flat base case.	875 ft./sec = 307.38 m/sec	3.5 ton/in. ² = 551.2 kg/cm ²
3½ drams powder = about 6.20 g. 1¼ oz. = 35.44 g shot. 2¾ in. flat base case.	925 ft./sec = 282 m/sec	4¼ ton/in. ² = 748 kg/cm ²
E. C. and Schultze Powders		
3 dram charge = 5.30 g. 1½ oz. = 31.89 g shot. 2½ in. flat base cases.	870 ft./sec = 265.2 m/sec	
3½ drams charge = 6.20 g. 1¼ oz. = 35.44 g shot. 2¾ in. flat base cases.	890 ft./sec = 271.3 m/sec	4.1–4.5 ton/in. ² = 645.7–718.7 kg/cm ²

* Gelatinized with rifle powders.

TYPICAL BRITISH STANDARD PROOF

Lead crushers are used, the Eley 1918 Tables being employed to calculate the pressures from the remaining length. Pressure: $2\frac{1}{2}$ –3 ton/in.² = 393.7 – 472.5 kg/cm.² Velocity over 20 yards = V_{10} yd. or $V_{9.15}$ m = 320–335 m/sec.

Charges Which Give Standard Ballistics

Powder	Cali-ber	Length of cartridge case		Powder charge, wt.		Shot charge, wt.	
		in.	mm	grains	g	ounces	g
Smokeless Dia-	12	$2\frac{3}{4}$	70	36	2.33	$1\frac{1}{4}$	35.44
mond E. C. Empire	12	$2\frac{1}{2}$	65	33	2.14	$1\frac{1}{8}$	30.12
in flat base cases, 3	16	$2\frac{3}{4}$	70	31	2.01	1	28.35
drams = 33 grains	16	$2\frac{1}{2}$	65	28	1.81	$\frac{7}{8}$	24.81
Schultze Amberite	12	$2\frac{3}{4}$	70	46	2.98	$1\frac{1}{4}$	35.44
in flat base cases, 3	12	$2\frac{1}{2}$	65	42	2.72	$1\frac{1}{8}$	30.12
drams = 42 grains	16	$2\frac{3}{4}$	70	40	2.59	$1\frac{1}{8}$	30.12
	16	$2\frac{1}{2}$	65	36	2.53	$\frac{7}{8}$	24.81
Ballistite con-	12	$2\frac{3}{4}$	70	28	1.81	$1\frac{1}{4}$	35.44
densed powder in	12	$2\frac{1}{2}$	65	25	1.62	$1\frac{1}{8}$	30.12
cone base cases	16	$2\frac{3}{4}$	70	23	1.49	1	28.35
	16	$2\frac{1}{2}$	65	21	1.36	$\frac{7}{8}$	24.81
				drams			
Black powder in	12	$2\frac{3}{4}$	70	$3\frac{1}{4}$	5.75	$1\frac{1}{4}$	35.44
flat base cases, 3	12	$2\frac{1}{2}$	65	3	5.30	$1\frac{1}{8}$	31.89
drams = 84 grains	16	$2\frac{3}{4}$	70	3	5.30	1	28.35
	16	$2\frac{1}{2}$	65	$2\frac{3}{4}$	4.87	$\frac{7}{8}$	24.81

The bulk density of the 33 grain powders is 375–385 g per liter.

The bulk density of the 42 grain powders is 475–485 g per liter.

The bulk density of Sporting Ballistite is 700–710 g per liter.

RIFLE POWDERS

For rifle powders there are no fixed standard ballistics such as have been established for shotgun powders. As an example some data are given for the 7 mm Mauser rifle.

7 mm Mauser Rifle

Powder	Powder charge, grains	Weight of bullet, grains	Muzzle velocity, ft./sec	Pressure
American Military Rifle powder (a)...	48	139	2900	Best burning pressure, 3515–3967 kg/cm ²
(b).....	42.5	139	2750	
	44.0	139	2900	
(c).....	36.9	175	2300	2320–2671 kg/cm ²
	40	175	2400	
	44	139	2786	
	45.5	139	2950	
(d).....	5.0	84	950	703–1055 kg/cm ²
	8.0	120	1150	
				Pressure aimed at:
British Rifle Ne-	38	173	2300	17.5 ton/in. ²
onite.....	43	140	2800	19.5 ton/in. ²

ORDNANCE POWDER

Here also, as in the case of rifle powders, the ballistic values required are fixed in advance, and the powder is modified in composition, in size and shape of grain, or by coating to modify its rate of burning. Examples are given of ballistics for the 7.5 cm field gun.

7.5 cm Field Gun

Gun	Powder charge, kg	Weight of projectile, kg	Muzzle velocity, m/sec	Range, km
U. S. A., 75 mm (Model 1923)....		6.8	665	13.5
Switzerland.....		6.35	250–485	8.6
France.....		7.25 (shrapnel)	550	11
		7.98 (H. E. shell)		
Japan (Model 05)...	0.631	6.8 (shrapnel)	510	5.8
	0.631	6.4 (H. E. shell)		8.35

LITERATURE

(For a key to the periodicals see end of volume)

- (1) Berthelot, *Sur la force des matières explosives d'après la thermochimie*. 3rd ed., Paris, 1883. (2) Bichel, 172 (5th), 2: 462; 03. (3) Bichel, *New method of testing explosives*. Philadelphia, Lippincott, 1904. (4) Bichel, *Glückauf*, 41: 1194; 05. (5) Blochmann, 245, 1: 80; 06. (6) Brunswick, *Explosivstoffe*. 2nd ed., Leipzig, Barth, 1923. (7) Comey, 172 (7th), 3B: 28; 09. (7.5) Comey and Holmes, 172 (8th), 25: 217; 12. (8) Dautriche, 315, 16: 27; 11. (9) Escalles and Stettbacher, *Initial explosivesstoffe*. Leipzig, Veit, 1917.
- (10) Flurschein, 245, 8: 185; 13. (11) Förg, 245, 11: 17, 37; 16. (12) Förg, 245, 11: 351; 16. (13) Great Britain, Explosives in Mines Research Committee, *Explosives for use in fiery and dusty mines*. 1923. (14) Hall, Snelling and Howell, 29, No. 15: 11. (14.5) Bureau of Mines, Reports of Investigations, Serial No. 2243, p. 11. (15) Hall and Howell, 30, No. 66: 13. (16) Justrow, 245, 17: 85, 22. (17) Kast, 245, 8: 65, 88, 133, 155, 172; 13. (18) Kast, 245, 10: 79; 15. (19) Kast, 245, 15: 171, 181; 20. (19.5) Kast, 245, 15: 195; 20.
- (20) Kast, 92, 36: 72; 23. (21) Kast and Haid, 92, 38: 43; 25. (22) Kibler, 172 (8th), 25: 238; 12. (23) Kling and Florentin, 34, 156: 694; 13. (24) MacNab and Leighton, 54, 23: 298; 04. (25) Marshall, *Explosives, their manufacture, tests, properties and history*. 2nd ed., Philadelphia, Blakiston, 1917. (26) Martin, *Über Azide und Fulminate*. 1913. (27) Naoum and Aufschläger, 245, 19: 121; 24. (28) Naoum, *Nitroglycerin und Nitroglycerinsprengstoffe (Dynamite)*. Berlin, Springer, 1924. (29) Nobel and Co., 245, 2: 281, 306; 07.
- (30) Robertson, 4, 119: 1; 21. (31) Robertson, *Proc. Roy. Instn.*, 23: 358; 21. (32) Stettbacher, *Die Schiess- und Sprengstoffe*. Leipzig, Barth, 1919. (33) Stettbacher, 245, 16: 139; 21. (34) Storm and Cope, 30, No. 125: 16. (35) Taylor and Cope, 30, No. 162: 17. (36) Will, 245, 1: 209; 06. (37) Will, 9, 12: 558; 06. (38) Wöhler and Matter, 245, 2: 181, 203, 244, 265; 07.
- (The following references to the *Jahresbericht der Centralstelle für wissenschaftlich-technische Untersuchungen*, Neubabelsberg-Berlin, include only volume, page and year. They could not be identified as to authors in the Editorial Office.)
- (39) 5: 124; 04. (40) 6: 112; 05. (41) 5: 73; 04. (42) 6: 60; 05. (43) 6: 131; 05. (44) 6: 160; 05. (45) 7: 111, 175; 06. (46) 8: 102; 07. (47) 10: 113; 09. (48) 11: 173; 10. (49) 13: 59; 12. (50) 13: 110, 116; 12.

LITERATURE REFERENCES

LITERATURE REFERENCES

In all literature references cited in International Critical Tables the name of the journal or publication is indicated by means of a *Key number* corresponding to the list given below. The numbers which follow this key number in a literature citation are, in the order named: (1) the volume, (2) the page, and (3) the last two figures of the year. Thus 64V, 31: 253; 22, indicates Verslag koninklijke Akademie van Wetenschappen te Amsterdam, Vol. 31, page 253, 1922. Series numbers are not given. Key numbers referring to books and other non-serial publications are preceded by the letter *B*, and the volume number is given in roman numerals. Thus B10, IV: 191; 18, indicates Doelter, Handbuch der Mineralchemie, page 191 of Vol. 4 of the 1918 edition. The key number *O* is used to indicate "private communication from."

RÉFÉRENCES BIBLIOGRAPHIQUES

Le nom du journal ou de la publication de toutes les références bibliographiques citées dans les Tables Critiques Internationales est indiqué au moyen d'un *nombre-clé* correspondant à la liste donnée ci-dessous. Les nombres qui suivent ce nombre-clé dans un renvoi bibliographique indiquent dans l'ordre suivant: (1) le volume, (2) la page, et (3) les deux derniers chiffres de l'année. Ainsi 64V, 31: 253; 22, indique Verslag koninklijke Akademie van Wetenschappen te Amsterdam, Vol. 31, page 253, 1922. Les numéros des séries ne sont pas donnés. Les nombres-clés se rapportant à des livres ou à des publications non périodiques sont précédés de la lettre *B* et le numéro du volume est donné en chiffres romains. Ainsi B10, IV: 191; 18, indique Doelter, Handbuch der Mineralchemie, page 191 du volume 4 de l'édition de 1918. Le nombre-clé *O* est employé pour indiquer "communication privée de."

DAS LITERATURVERZEICHNIS

In allen Literaturstellen, die in I. C. T. verzeichnet sind, ist der Name der Zeitschrift oder der Publikation mit Hilfe einer *Schlüsselnummer*, entsprechend der unten folgenden Liste, angegeben. Die Zahlen, welche diesen Schlüsselnummern bei einem Literaturzitat folgen, bedeuten der Reihe nach: (1) der Band, (2) die Seite, und (3) die letzten zwei Zahlen des Jahrganges. So bedeutet z. B. 64V, 31: 253; 22, Verslag koninklijke Akademie van Wetenschappen te Amsterdam, Band 31, Seite 253, 1922. Seriennummern werden nicht angegeben. Der Schlüsselzahl wird ein *B* vorausgesetzt, wenn sie Bücher, oder eine andere nicht periodische Veröffentlichung bezeichnet. Die Bandnummer wird durch römische Ziffern angegeben. Es bedeutet z. B. also B10, IV: 191; 18, Doelter, Handbuch der Mineralchemie, Seite 191, des 4 Bandes, der Auflage des Jahres 1918. Die Schlüsselzahl *O* wird gebraucht, um anzuzeigen, dass es eine "private Mitteilung" ist.

INDICAZIONI BIBLIOGRAFICHE

In tutte le indicazioni bibliografiche che si incontrano nelle "Tabelle Critiche Internazionali" il nome del giornale o della pubblicazione è espresso con un *numero chiave* riportato nell'elenco dato più oltre. I numeri che, nella citazione, vengono dopo il numero chiave sono disposti con l'ordine seguente: (1) il volume, (2) la pagina, e (3) le ultime due cifre del millesimo. Così 64V, 31: 253; 22, indica la Verslag koninklijke Akademie van Wetenschappen te Amsterdam, Vol. 31, pagina 253, 1922. I numeri di serie non vengono dati. Quando un numero chiave è preceduto dalla lettera *B* si riferisce a libri o ad altre pubblicazioni non periodiche, e il numero del volume viene allora scritto in cifre romane. Così B10, IV: 191; 18, indica Doelter, Handbuch der Mineralchemie, pagina 191 del IV° volume dell'edizione 1918. Il numero chiave *O* indica "Comunicazione privata da . . ."

KEY TO THE PERIODICALS

Data regarding the libraries which receive many of these periodicals may be found through the following sources:

United States and Canada: "Periodicals Abstracted by Chemical Abstracts, 1926" (Chemical Abstracts, Ohio State Univ., Columbus, Ohio); "Union List of Serials in the Libraries of the United States and Canada, 1927" (H. W. Wilson & Co., New York City); "A Catalogue of Scientific Periodicals in Canadian Libraries, 1924" (McGill Univ., Montreal, Canada).

Great Britain: "A World List of Scientific Periodicals Published in the Years 1900-1921" (Oxford Univ. Press, London, 1925-1927).

Holland: "Chemisch Jaarboekje tevens Jaarboekje der Nederlandsche Chemische Vereeniging, Vol. 3." (Amsterdam, D. B. Centen, 1920).

1. Journal of the American Chemical Society.
2. Physical Review.
3. London, Edinburgh and Dublin Philosophical Magazine and Journal of Science.
4. Journal of the Chemical Society, London. (Memoirs of the Chemical Society; *continued as* Quarterly Journal; *later* Journal.)
5. Proceedings of the Royal Society (London). A. Mathematical and Physical Sciences.
- 5B. Proceedings of the Royal Society (London). B. Biological Sciences.
6. Annales de chimie et de physique. (*Divided into* Nos. 14 and 16 *in* 1914).
7. Zeitschrift für physikalische Chemie, Stöchiometrie und Verwandtschaftslehre.
8. Annalen der Physik. [Journal der Physik, 1790-1794. Neues Journal der Physik, 1795-1796. Annalen der Physik, 1799-1819; Annalen der Physik und der physikalischen Chemie, 1819-1824 (Gilbert). Annalen der Physik und Chemie, 1824-1899 (Poggendorff, Wiedemann). Annalen der Physik, 1900- (Drude, Wien and Planck).]
9. Zeitschrift für Elektrochemie und angewandte physikalische Chemie.
10. Tables annuelles internationales de constantes et données numériques.
11. American Chemical Journal. (*Combined with* No. 1 *in* 1914.)
12. American Journal of Science. (American Journal of Science and Arts, 1820-79; *known also as* Silliman's Journal of Science.)
13. Annalen der Chemie, Justus Liebig's.
14. Annales de chimie.
15. Annales des mines ou recueil de mémoires sur l'exploitation des mines et sur les sciences et les arts qui s'y rattachent.
16. Annales de physique.
17. Anzeiger der Akademie der Wissenschaften in Wien. Mathematisch-naturwissenschaftliche Klasse.
18. Archives néerlandaises des sciences exactes et naturelles. Séries IIIA (Sciences exactes).
- 18B. Archives néerlandaises de physiologie de l'homme et des animaux. (Séries IIIC of No. 18.)
19. Arkiv för Kemi, Mineralogi och Geologi.
20. Arkiv för Matematik, Astronomi och Fysik.
21. Astrophysical Journal.

22. Atti della reale accademia nazionale dei Lincei. (Rendiconti classe di scienze fisiche, matematiche e naturali.)
23. Atti della reale accademia delle scienze di Torino.
24. Atti del reale istituto Veneto di scienze, lettere ed arti.
25. Berichte der deutschen chemischen Gesellschaft.
26. Berichte der deutschen physikalischen Gesellschaft. *See also* No. 96.
27. Bulletin de la société chimique de France. (*Before 1908 was* Bulletin de la société chimique de Paris.)
28. Bulletin de la société chimique de Belgique. (*Before 1904 was* Bulletin de l'association belge des chimistes.)
29. Bureau of Mines, Bulletins.
30. Bureau of Mines, Technical Papers.
31. Bureau of Standards, Scientific Papers. (*Continued as* No. 546.)
- 31A. Bureau of Standards, Bulletin. (*Continued as* No. 546.)
32. Bureau of Standards, Technologic Papers. (*Continued as* No. 546.)
33. Chemical and Metallurgical Engineering. (*Name changed July, 1918, from* Metallurgical and Chemical Engineering.)
34. Comptes rendus hebdomadaires des séances de l'académie des sciences, de l'institut de France.
35. Elektrochemische Zeitschrift.
36. Gazzetta chimica italiana.
37. Helvetica Chimica Acta.
38. Journal of the American Ceramic Society.
- 38B. Bulletin of the American Ceramic Society.
39. Journal of the American Institute of Electrical Engineers.
40. Journal of the American Institute of Metals. (*See* No. 329.)
41. Journal of the Chemical Society of Japan (Nippon Kwagaku Kwai Shi). (*Name changed in Jan., 1921, from* Journal of the Tokyo Chemical Society.)
- 41B. Bulletin of the Chemical Society of Japan.
42. Journal de chimie physique.
43. Journal of the Faculty of Engineering, Tokyo Imperial University.
44. Journal of the Faculty of Science, Tokyo Imperial University.
45. Industrial and Engineering Chemistry. (*Name changed Jan., 1923, from* Journal of Industrial and Engineering Chemistry.)
46. Journal of the Institution of Electrical Engineers (London).
47. Journal of the Institute of Metals (London).
48. Journal of the Optical Society of America and Review of Scientific Instruments.
49. Journal de pharmacie et de chimie.
50. Journal of Physical Chemistry.
51. Journal de physique et le radium. (*Formed from* Le radium *and* Journal de physique, théorique et appliquée.)
52. Journal für praktische Chemie.
53. Journal of the Russian Physico-Chemical Society. (Chemical part.)
54. Journal of the Society of Chemical Industry.
55. Kolloid-Zeitschrift. (*Formerly* Zeitschrift für Chemie und Industrie der Kolloide.)
56. Mechanical Engineering. (*Formerly* Journal of the American Society of Mechanical Engineers.)

57. Monatshefte für Chemie und verwandte Teile anderer Wissenschaften.
58. Nature (London).
59. Nuovo Cimento.
60. Översigt af Finska Vetenskaps-Societetens, Förhandlingar. (*Discontinued with* Vol. 64, 1921–22.)
61. Oversigt over det Kongelige Danske Videnskabernes Selskabs, Forhandlingar.
62. Philosophical Transactions of the Royal Society of London. Series A, Physical and Mathematical.
- 62B. Philosophical Transactions of the Royal Society of London. Series B, Biological.
63. Physikalische Zeitschrift, vereinigt mit dem Jahrbuch der Radioaktivität und Elektronik.
- 64P. Proceedings of the Royal Academy of Sciences of Amsterdam.
- 64V. Verslag koninklijke Akademie van Wetenschappen te Amsterdam.
65. Proceedings of the American Academy of Arts and Sciences.
66. Proceedings of the American Society for Testing Materials.
67. Proceedings of the Physical Society of London.
68. Proceedings of the Royal Society of Edinburgh.
69. Proceedings and Transactions of the Royal Society of Canada.
70. Recueil des travaux chimiques des Pays-Bas.
71. Rendiconti dell'accademia delle scienze fisiche e matematiche. (Classe della società reale di Napoli.)
72. Rendiconti reale istituto Lombardo di scienze e lettere.
73. Rendiconti della società chimica italiana.
74. Revue de métallurgie.
- 74E. Revue de métallurgie, Extraits.
75. Sitzungsberichte Akademie der Wissenschaften in Wien, mathematisch-naturwissenschaftliche Klasse.
76. Sitzungsberichte der preussischen Akademie der Wissenschaften.
77. Stahl und Eisen.
78. Transactions of the American Electrochemical Society.
79. Transactions of the American Institute of Chemical Engineers.
80. Transactions of the American Institute of Mining and Metallurgical Engineers.
81. Transactions of the American Ceramic Society. (*Continued in 1917 by* No. 38.)
82. Transactions of the Ceramic Society (England).
83. Transactions of the Faraday Society.
84. Transactions of the Illuminating Engineering Society (New York).
85. Transactions of the Optical Society (London).
86. University of Illinois, Engineering Experiment Station, Bulletin.
87. Verhandelingen der koninklijke Akademie van Wetenschappen te Amsterdam.
88. Verhandlungen der physikalischen Gesellschaft zu Berlin. (*See also* No. 96.)
89. Wissenschaftliche Abhandlungen der physikalisch-technischen Reichsanstalt.
90. Wissenschaftliche Abhandlungen der Kaiserlichen Normal-Eichungs-Kommission. (*Now* Reichsanstalt für Mass und Gewicht.)
91. Zeitschrift für analytische Chemie.
92. Zeitschrift für angewandte Chemie.
93. Zeitschrift für anorganische und allgemeine Chemie. (*Name changed in 1915 from* Zeitschrift für anorganische Chemie.)
94. Zeitschrift für Krystallographie. (*Name changed in 1921 from* Zeitschrift für Krystallographie und Mineralogie.)
95. Zeitschrift für Metallkunde. (*Formerly* Internationale Zeitschrift für Metallographie.)
96. Zeitschrift für Physik. (Verhandlungen der physikalischen Gesellschaft zu Berlin, 1882–1898; Verhandlungen der deutschen physikalischen Gesellschaft, 1899–1902; Berichte der deutschen physikalischen Gesellschaft, 1903–1919; Zeitschrift für Physik, 1920–.)
97. Zeitschrift für technische Physik.
98. Zeitschrift des Vereines deutscher Ingenieure.
99. Zeitschrift für wissenschaftliche Photographie, Photophysik und Photochemie.
100. Sprechsaal, Zeitschrift für die keramischen, Glas- und verwandten Industrien.
101. Elektrotechnische Zeitschrift.
102. Céramique.
103. Keramische Rundschau.
104. Berichte der deutschen keramischen Gesellschaft.
105. Journal of the Society of Glass Technology.
106. Revue générale de l'électricité.
107. Electrical World.
108. Electrical Review (London).
109. National Advisory Committee for Aeronautics, Annual Reports.
110. New Jersey Ceramist.
111. New Zealand Journal of Science and Technology
112. Dinglers polytechnisches Journal.
113. Berichte der technisch-wissenschaftliche Abteilung des Vereines keramische Gewerbe im Deutschland.
114. Electric Journal.
115. Engineering.
116. Sibley Journal of Engineering.
117. Scientific Proceedings of the Royal Dublin Society.
118. Annales de l'institut polytechnique du Don, Novocerkask.
119. Proceedings of the American Institution of Electrical Engineers. (*Discontinued in 1919.*)
120. General Electric Review.
121. Electrician.
122. Journal of the American Society of Mechanical Engineers. (*See* No. 56.)
123. British Clayworker.
124. Silikat-Zeitschrift.
125. Archiv für Elektrotechnik. (*Supplement to* No. 101.)
126. Bulletin de la société française des électriciens.
127. Elettrotecnica.
128. Journal of the Washington Academy of Sciences.
129. Transactions of the American Institute of Electrical Engineers.
130. Technische Studien.
131. American Journal of Physiology.
132. Anales de la sociedad española de física y química.
133. British Association for the Advancement of Science, Reports.
134. Bulletin de l'académie des sciences de l'union des républiques soviétiques socialistes. (*Formerly* Bulletin de l'académie impériale des sciences de St. Pétersbourg; *name changed in 1917 to* Bulletin de l'académie des sciences de Russie; *present name dates from 1925.*)
135. Chemical News and Journal of Industrial Science. (*Name changed in 1921 from* Chemical News and Journal of Physical Science.)
136. Chemiker-Zeitung.
137. Kongelige Danske Videnskabernes Selskab. Mathematisk-fysiske Meddelelser.
138. Societas scientiarum fennica. Commentationes physio-mathematicae.
139. Ferrum.
140. Journal of the Iron and Steel Institute, London.
141. Journal of Biological Chemistry.

142. Journal of the Society of Chemical Industry, Japan. (*Formerly* Journal of Chemical Industry, Japan.)
143. Journal of The Franklin Institute.
144. Matematikai és Természettudományi Ertesítő, Budapest.
145. Zeitschrift für Biologie.
146. Zement und Beton.
147. Meddelanden från K. Vetenskapsakademiens Nobelinstitut.
148. Zeitschrift für die gesamte Kälte-Industrie.
149. Archives des sciences physiques et naturelles. (Bibliothèque britannique, 1796–1815; Bibliothèque universelle des sciences, belles-lettres et arts, 1816–1835; Bibliothèque universelle de Genève 1836–1845; Supplément à la bibliothèque universelle de Genève. Archives des sciences physiques et naturelles, 1846–1847; Bibliothèque universelle de Genève. Archives des sciences physiques et naturelles, 1848–1857; Bibliothèque universelle, revue suisse et étrangère. Archives des sciences physiques et naturelles, 1858–1861; Bibliothèque universelle et revue suisse. Archives des sciences physiques et naturelles, 1862–1867; Bibliothèque universelle. Archives des sciences physiques et naturelles, 1878–.)
150. Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens insbesondere aus dem Laboratorium der technischer Hochschulen. Verein deutscher Ingenieure.
151. Mémoires de l'académie royale des sciences de l'institut de France.
152. Carnegie Institution of Washington, Publications.
153. Minutes of Proceedings of the Institution of Civil Engineers.
154. Iowa Geological Survey, Bulletin.
155. Missouri Bureau of Geology and Mines.
156. U. S. Geological Survey, Bulletin.
157. U. S. Department of Agriculture, Bulletin.
158. New York State Museum, Bulletin.
159. Science Reports of the Tôhoku Imperial University. Series I, Mathematics, Physics and Chemistry.
- 159B. Science Reports of the Tôhoku Imperial University. Series III, Petrology, Mineralogy and Mineral Deposits.
160. Arkansas Geological Survey, Annual Reports.
161. Mitteilungen aus dem königlichen technischen Versuchsanstalten zu Berlin. (*See also* No. 312.)
162. Mitteilungen aus dem Mechanisch-technischen Laboratorium der technischen Hochschule in München.
163. Minnesota Geological and Natural History Survey.
164. Colorado, Biennial Report Capitol Managers.
165. Bulletin internationale de l'académie des sciences de Cracovie. (*Name changed to* Bulletin internationale de l'académie Polonaise des sciences et des lettres.)
166. Science.
167. Jahresbericht über die Fortschritte der Chemie und verwandte Theile anderer Wissenschaften.
168. Communications from the Physical Laboratory at the University of Leiden.
169. Annales de l'Institut Polytechnique Pierre-le-Grand, Pétrograd.
170. Memorie della reale accademia nazionale dei Lincei, Roma.
171. Sitzungsberichte der Heidelberger Akademie der Wissenschaften. Mathematisch-naturwissenschaftliche Klasse. Abteilung A.
172. International Congress of Applied Chemistry.
173. Analyst, London.
174. Transactions of the Royal Society of Edinburgh.
175. Annales academiae scientiarum fennicae.
176. Chemisch Weekblad, Amsterdam.
177. Annales scientifiques de l'université de Jassy.
178. Archivio di fisiologia (Florence).
179. Nachrichten (Iswesti) des Polytechnikums, Petrograd.
180. Anzeiger der Akademie der Wissenschaften, Krakau.
181. Travaux de la société de physique et de chimie de Kharkoff.
182. Proceedings of the Chemical Society, London.
183. Annales de l'Institut électrotechnique Alexander III, Pétrograd.
184. American Journal of Pharmacy.
185. Chemisches Zentralblatt.
186. Bulletin de la classe des sciences, académie royale de Belgique.
187. Metall und Erz, Zeitschrift für Metallhüttenwesen und Erzbergbau, einschl. Aufbereitung.
188. Nachrichten von der königlichen Gesellschaft der Wissenschaften zu Göttingen. Geschäftliche Mitteilungen; mathematisch-physikalische Klasse.
189. Centralblatt für Mineralogie, Geologie und Paläontologie.
190. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie.
- 190B. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Beilage Band.
191. Bulletin de la société française de minéralogie.
192. Metallurgie. (*Divided into* Nos. 139 and 187.)
193. Mitteilungen der Naturforschenden Gesellschaft zu Halle.
194. Journal of the Science Association, Maharajah's College.
195. Sitzungsberichte der Dorpater Naturforscher-Gesellschaft an der Universität.
196. Sammlung chemischer und chemisch-technischer Vorträge.
197. Proceedings of the National Academy of Sciences.
198. Revue générale des sciences pures et appliquées.
199. Le Radium. (*Merged into* No. 51 in 1920.)
200. Jahrbuch der Radioaktivität und Elektronik. (*Combined with* No. 63 in 1924.)
201. Proceedings of the Cambridge Philosophical Society.
202. Zeitschrift für physiologische Chemie.
203. Archiv für Anatomie und Physiologie. Physiologische Abteilung. (*Merged with* No. 278.)
204. Photographic Journal.
205. Biochemische Zeitschrift.
206. Comptes rendus des séances de la société de biologie.
207. Geologiska Föreningen i Stockholm, Förhandlingar.
208. Physica, Nederlandsch Tijdschrift voor Natuurkunde.
209. Japanese Journal of Chemistry.
210. Scientific Papers, Institute of Physical-Chemical Research. Tokyo.
211. Abhandlungen der sächsischen Akademie der Wissenschaften zu Leipzig. Mathematisch-physischen Klasse.
212. Transactions of the American Society for Steel Treating.
213. Sitzungsberichte der bayerischen Akademie der Wissenschaften zu München. Mathematisch-physikalischen Klasse.
214. Kongelige Danske Videnskabernes Selskab, Skrifter naturvidenskabelig og matematisk Afdeling.
215. Lunds Universitets Årsskrift.
216. Giornale di chimica industriale ed applicata. (*Annali di chimica applicata, 1914; continued as* Giornale di chimica applicata; *combined with* Giornale di chimica industriale, March, 1920, to form Giornale di chimica industriale ed applicata.)
217. U. S. Coast and Geodetic Survey, Special Publications.
218. Naturwissenschaften.
219. Proceedings of the Physico-Mathematical Society of Japan.
220. Jern-Kontorets Annaler, Stockholm.
221. Berichte der sächsischen Akademie der Wissenschaften zu Leipzig. Mathematisch-physische Klasse.
222. Giornale di mineralogia, cristallografia e petrografia.
223. Journal of General Physiology.
224. Kosmos, Stockholm.
225. Kosmos. (Polskie towarzystwo przyrodników imienia Kopernika.) Lemberg.
226. Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung zu Düsseldorf.

227. Proceedings of the Society for Experimental Biology and Medicine.
228. Denkschriften der kaiserlichen Akademie der Wissenschaften zu Wien. Mathematisch-naturwissenschaftliche Klasse.
229. Journal of Bacteriology.
230. Biochemical Journal.
231. U. S. Public Health Service, Public Health Reports.
232. Soil Science.
233. Pharmaceutisch Weekblad.
234. Journal of the South African Chemical Institute. (*Name changed in 1922 from Journal of the South African Association of Analytical Chemists.*)
235. Comptes-rendus des travaux du laboratoire Carlsberg.
236. Ergebnisse der Physiologie.
237. Fortschritte der Chemie, Physik und physikalischen Chemie.
238. Travaux et mémoires du bureau international des poids et mesures.
239. Nouveaux mémoires de l'académie royale des sciences, des lettres et des beaux-arts de Belgique, Brussels.
240. Bibliothèque universelle des sciences, belles-lettres et arts. (*Continued as No. 149.*)
241. Proceedings of the American Philosophical Society.
242. Vierteljahrsschrift der naturforschenden Gesellschaft, Zürich.
243. Zeitschrift für Instrumentenkunde.
244. Journal of the Society of Automotive Engineers.
245. Zeitschrift für das gesamte Schiess- und Sprengstoffwesen.
246. Ice and Refrigeration.
247. Chemist-Analyst.
248. Proceedings of the University of Durham Philosophical Society.
249. Fortschritte auf dem Gebiete der Röntgenstrahlen.
250. Bulletin de séances de la société française de physique (1873–1910). (*From 1873–1901 as its Séances; continued as No. 51.*)
251. Proceedings of the Royal Society of Victoria, Melbourne.
252. Chemische Umschau auf dem Gebiete der Fette, Oele, Wachse und Harze. (*Before 1916 Chemische Revue über die Fett- und Harz-Industrie.*)
253. Lubrication.
254. Zeitschrift für Beleuchtungswesen, Heizungs- und Lüftungstechnik.
255. Bulletin of the American Institute of Mining and Metallurgical Engineers. (*Continued as No. 329.*)
256. Comptes rendus de la société scientifique, Warsaw.
257. Bulletin of the Imperial Institute, London. (*Before 1903, Imperial Institute Journal.*)
258. Le cuir. Edition technique. (*Name changed Nov., 1923 to Le cuir technique.*)
259. Collegium.
260. Indian Forest Records.
261. Journal of the American Leather Chemists' Association.
262. Journal of the International Society of Leather Trades' Chemists. (*Before Oct., 1925, Journal of the Society of Leather Trades' Chemists.*)
263. Leather Trades' Review.
264. Ledertechnische Rundschau. (*Technical supplement of Der Lederindustrie.*)
265. Queensland Agricultural Journal.
266. Indianapolis Medical Journal.
267. Philippine Journal of Science.
268. Terrestrial Magnetism.
269. Mineralogical Magazine and Journal of the Mineralogical Society.
270. Berichte der naturforschenden Gesellschaft zu Freiburg, im Breisgau.
271. Revue scientifique.
272. Transactions of the Wisconsin Academy of Sciences, Arts and Letters.
273. Berichte der deutschen pharmazeutischen Gesellschaft. (*See also No. 293.*)
274. Pharmazeutische Zentralhalle für Deutschland.
275. International Sugar Journal.
276. Chemical Age, London.
277. Archiv für experimentelle Pathologie und Pharmakologie.
278. Archiv für die gesamte Physiologie des Menschen und der Tiere. (Pflüger.)
279. Zeitschrift für Untersuchung der Lebensmittel. (*Formerly Zeitschrift für Untersuchung der Nahrungs- und Genussmittel sowie der Gebrauchsgegenstände.*)
280. Umschau.
281. Zeitschrift für Psychologie und Physiologie der Sinnesorgane.
282. Wochenschrift für Brauerei.
283. Journal de psychologie normal et pathologique.
284. Journal of the American Pharmaceutical Association.
285. Journal of Mathematics and Physics (Massachusetts Institute of Technology).
286. Chemical Reviews.
287. Kolloidchemische Beihefte.
288. Revue générale des colloïdes et de leurs applications industrielles.
289. Journal of Physiology.
290. Journal of the Society of Dyers and Colourists.
291. Arbeiten aus dem Reichsgesundheitsamte.
292. Proceedings and Transactions of the Nova Scotian Institute of Science.
293. Archiv der Pharmazie. (*Combined with No. 273 in 1924 to form Archiv der Pharmazie und Berichte der deutschen pharmazeutischen Gesellschaft.*)
294. Mémoires de l'académie de Belgique.
295. Proceedings of the American Wood-Preservers' Association.
296. Kunststoffe, Zeitschrift für Erzeugung und Verwendung veredelter oder chemisch hergestellter Stoffe.
297. National Advisory Committee on Aeronautics. Technical Reports.
298. National Advisory Committee on Aeronautics. Technical Notes.
299. British Aeronautical Research Committee. Reports and Memoranda.
300. British Advisory Committee on Aeronautics. Reports and Memoirs.
301. Jahrbuch der Motorluftschiff-Studiengesellschaft.
302. Smithsonian Institution Publications. Miscellaneous Collection.
303. Bulletin de l'institut aérodynamique de Koutchino, Pétrograd.
304. Aerodynamische Versuchsanstalt zu Göttingen. Ergebnisse.
305. Transactions of the American Society of Civil Engineers.
306. Journal of the American Society of Naval Engineers.
307. Iron and Coal Trades Review.
308. Fortschritte der Mineralogie, Kristallographie und Petrographie.
309. Bulletin of the Lewis Institute, Structural Materials Research Laboratory, Chicago.
310. Transactions of the National Lime Manufacturers' Association.
311. France-Belgique. (*Revue de l'ingénieur et index technique merged with this in 1922.*)
312. Mitteilungen aus dem Materialprüfungsamt und dem Kaiser-Wilhelm-Institut für Metallforschung zu Berlin-Dahlem. (*Mitteilungen aus dem königlichen technischen Versuchsanstalten zu Berlin, 1883–1903; in 1904 became Mitteilungen aus dem königlichen Materialprüfungsamt zu Gross-Lichter-*

- felde West; *later becoming* Mitteilungen aus dem königlichen Materialprüfungsamt zu Berlin-Lichterfelde West; *name changed in 1919 to* Mitteilungen aus dem Materialprüfungsamt zu Berlin-Lichterfelde West; *name changed in 1920 to* Mitteilungen aus dem Materialprüfungsamt zu Berlin-Dahlem; *present name dates from 1923.*)
313. U. S. Bureau of Mines, Reports of Investigations.
314. Tonindustrie-Zeitung.
315. Mémorial des poudres. (*Formerly* Mémorial des poudres et salpêtres.)
316. Journal and Proceedings of the Royal Society of New South Wales.
317. Chemische Industrie. (*Combined with* No. 92 *in 1921; separated again in 1923.*)
318. Journal of the Indian Institute of Science.
319. Die deutsche pharmazeutische Zeitung.
320. Journal of Analytical and Applied Chemistry. (*Merged into* No. 1 *in 1893.*)
321. Transactions of the Royal Dublin Society.
322. Schriften der Dorpater Naturforscher-Gesellschaft an der Universität.
323. Jahrbuch der königlichen kaiserlichen geologischen Reichsanstalt.
324. Canadian Chemistry and Metallurgy.
325. Proceedings of the Royal Institution of Great Britain.
326. Astronomical Journal.
327. Annales de la société scientifique de Bruxelles.
328. American Mineralogist.
329. Mining and Metallurgy. (Transactions of the American Brass Founders' Association, 1908-11; Transactions of the American Institute of Metals, 1912-16; Journal of the American Institute of Metals, 1917-18; *discontinued in 1918 and incorporated with* Bulletin of the American Institute of Mining Engineers; *with issue* No. 148, 1919, *this Bulletin became* Bulletin of the American Institute of Mining and Metallurgical Engineers; *with issue* No. 154, 1919, *name changed again to* Mining and Metallurgy.)
330. Psychological Monographs.
331. Archives of Psychology.
332. Philosophische Studien.
333. Psychological Review.
334. Journal of Experimental Psychology.
335. American Journal of Psychology.
336. Bulletin of the Geological Society of America.
337. Bulletin of the National Research Council.
338. Researches of the Electro-Technical Laboratory (Tokyo).
339. American Journal of Mathematics.
340. Philippine Agriculturist.
341. Journal of Agricultural Research.
342. Annales de chimie analytique et de chimie appliquée et revue de chimie analytique réunies.
343. Zeitschrift für öffentliche Chemie. (*Suspended at end of 1922.*)
344. Apotheker Zeitung.
345. Bulletin des sciences pharmacologiques.
346. Malayan Agricultural Journal. (*Formerly* Bulletin of the Department of Agriculture, Federated Malay States.)
347. Pharmaceutical Journal and Pharmacist.
348. Cotton Oil Press.
349. Seifensieder-Zeitung und Rundschau über die Harz-, Fett- und Ölindustrie mit dem Beiblatt: Der chemisch-technische Fabrikant.
350. Les matières grasses.
351. Journal of State Medicine, London.
352. Milchwirtschaftliche Zentralblatt. (*Name changed in 1912 from* Milch-Zeitung.)
353. Academia caesarea leopoldino carolina germanica naturae curiosorum.
354. National Physical Laboratory, Collected Researches and Reports, London.
355. The Engineer, London.
356. Journal of the Royal Society of Arts.
357. Anales de la asociación química Argentina. (*Name changed Jan., 1921, from* Anales de la sociedad química Argentina.)
358. Journal of the Institution of Petroleum Technologists and Record of Transactions.
359. Petroleum Age. (Petroleum; *name changed to* Petroleum Magazine, *and then back to* Petroleum; *in Sept., 1921, combined with* Petroleum Age *to form* Petroleum Age *including* Petroleum; *name changed back to* Petroleum Age, Dec., 1925.)
360. National Petroleum News.
361. Petroleum, Zeitschrift für die gesamten Interessen der Mineralöl-Industrie und des Mineralöl-Handels. (*Formerly* Petroleum, Zeitschrift für die gesamten Interessen der Petroleum-Industrie und des Petroleum-Handels.)
362. Chemické Listy pro vědu a Průmysl.
363. Petroleum Review. (*Replaced by* No. 364.)
364. Petroleum Times. (*See* No. 363.)
365. Bureau of Standards, Circulars.
366. Feuerungstechnik.
367. Oesterreichische Chemiker-Zeitung.
368. Proceedings of the Institution of Automobile Engineers, London.
369. Gornyi zhurnal.
370. Memoirs of the American Academy of Arts and Sciences, Boston.
371. University Geological Survey of Kansas, Reports.
372. Verein zur Beförderung des Gewerbefleißes, Verhandlungen.
373. Chemisch-technisches Repertorium. (*Supplement to* No. 136.)
374. Oil and Colourman's Journal.
375. Polytechnisches Centralblatt.
376. Automotive Industries.
377. Bulletin de la section scientifique de l'académie Roumaine.
378. Chimie et industrie.
379. Journal of the Japanese Ceramic Society.
380. Gesundheits-Ingenieur.
381. Automobile Engineer and Internal Combustion Engineering. (Automobile Engineer, London, 1910 to Oct., 1912; Internal Combustion Engineering, Oct., 1912, to Jan., 1914; *present name since* Jan., 1914.)
382. Refrigerating Engineering. (Transactions of the American Society of Refrigerating Engineers, 1905-13; American Society of Refrigerating Engineers Journal; *present name dates from* July, 1922.)
383. Revue générale du froid et des industries frigorifiques.
384. Le génie civil, Paris.
385. Journal of the American Society of Heating and Ventilating Engineers.
386. Canada Department of Mines.
387. Mineral Industry.
388. Öfversigt af kongl. Svenska Vetenskaps-Akademien, Förhandlingar.
389. South African Journal of Industries. (*United with the* Official Labour Gazette of the Union of South Africa *in 1925 to form the* South African Journal of Industries and Labour Gazette.)
390. Indian Forest Bulletin.
391. Indian Forester.
392. Indian Forest Pamphlet.
393. American Society for Testing Materials, Standards.

394. Fuel in Science and Practice.
395. Engineering and Mining Journal-Press. (*Formed in April, 1922 by the combining of Engineering and Mining Journal with Mining and Scientific Press; name changed July, 1926, to Engineering and Mining Journal.*)
396. Gas Journal. (*Formerly Journal of Gas Lighting and Water Supply.*)
397. Gas- und Wassersch. (*Name changed Jan., 1922, from Journal für Gasbeleuchtung und verwandte Beleuchtungsarten sowie für Wasserversorgung.*)
398. Memoirs and Proceedings of the Manchester Literary and Philosophical Society.
399. Colliery Guardian and Journal of the Coal and Iron Trades.
400. Beama.
401. Revue de l'industrie minérale. (*Bulletin de la société de l'industrie minérale; name changed Jan., 1921, to Revue de la société de l'industrie minérale; name changed to Revue de l'industrie minérale.*)
402. Technique moderne.
403. Proceedings of the Institution of Mechanical Engineers.
404. Engineering News-Record. (*Formed by the combining of Engineering News with Engineering Record.*)
405. Glückauf, Berg- und Hüttenmännische Zeitschrift.
406. Monthly Weather Review.
407. Jornal de Sciencias Mathematicas, Physicas e Naturales, Lisbon.
408. Journal de mathématiques pures et appliquées (Paris). (*Continues Annales de mathématiques pures et appliquées; present name dates from 1836.*)
409. Bayerisches Industrie- und Gewerbe-Blatt. (*Kunst- und Gewerbe-Blatt, 1815-68; present name dates from 1869.*)
410. Edinburgh Philosophical Journal, 1819-26; Edinburgh New Philosophical Journal, 1826-64; Quarterly Journal of Science, 1864-70; Quarterly Journal of Science and Annals of Mining, Metallurgy, Engineering, Industrial Arts, Manufactures and Technology, 1871-79; Monthly Journal of Science and Annals of Astronomy, Biology, Geology, Industrial Arts, Manufactures and Technology, 1879-85.
411. Proceedings of the North East Coast Institute of Engineers and Shipbuilders.
412. Horseless Age. (*Merged into Motor Age in 1918.*)
413. Journal of the Royal Aeronautical Society. (*Annual Report of the Royal Aeronautical Society, 1866-96; superseded by Aeronautical Journal; later Journal of the Royal Aeronautical Society.*)
414. Mitteilungen über Forschungsarbeiten auf den Gebiete des Ingenieurwesens hrsg. vom Vereine deutscher Ingenieure.
415. Journal of the Textile Institute.
416. Brennstoff-Chemie.
417. Iron and Steel Institute, Carnegie Scholarship Memoirs.
418. Pottery Gazette and Glass Trade Review.
419. Ohio Journal of Science. (*Name changed Nov., 1915, from Ohio Naturalist.*)
420. Bulletin de la société d'encouragement pour l'industrie nationale.
421. Journal of West Scotland Iron and Steel Institute.
422. American Machinist.
423. Transactions of the American Foundrymen's Association. (*Journal of the American Foundrymen's Association, 1896-1904.*)
424. Oesterreichische Zeitschrift für Berg- und Hüttenwesen. (*Merged into Montanistische Rundschau.*)
425. Deutsche Mechaniker-Zeitung. (*Beiblatt zur Zeitschrift für Instrumentenkunde.*)
426. Acta societatis scientiarum fennicae. (1839-1842, Commentationes societatis fennicae.)
427. Physikalische Berichte. (*Beiblätter zu den Annalen der Physik und Chemie; Beiblätter united with Fortschritte der Physik and Halbmonatliches Literaturverzeichnis to form Physikalische Berichte.*)
428. Repertorium für Experimental-Physik für physikalische Technik für mathematische und astronomische Instrumentenkunde. (*Before 1867 was Repertorium für physikalische Technik für mathematische und astronomische Instrumentenkunde; also known as Carl's Repertorium.*)
429. Memoirs of the College of Science, Kyoto Imperial University. (*Before 1914 was part of Memoirs of the College of Science and Engineering, Kyoto Imperial University.*)
430. Iron Age.
431. Revue de la société russe de métallurgie.
432. Transactions of the Institution of Mining and Metallurgy (London).
433. Annual Report of the Royal Mint, London.
434. Scientific Transactions of the Royal Dublin Society.
435. Proceedings of the Institution of British Foundrymen.
436. Reports of the Research Department, Royal Arsenal, Woolwich.
437. Japanese Journal of Physics.
438. Transactions of the American Society of Mechanical Engineers.
439. Mémoires et compte rendu des travaux de la société ingénieurs civils de France.
440. Metal Industry and the Iron Foundry (London).
441. India Rubber Journal.
442. Annals of Botany.
443. Archief voor de Rubbercultuur in Nederlandsch-Indië.
444. Verhandlungen der preussischen Akademie der Wissenschaften.
445. Zeitschrift des Vereins der deutschen Zucker-Industrie. (*Before 1898 was Zeitschrift des Vereins für die Rübenzucker-industrie.*)
446. Zeitschrift für die Zuckerindustrie der Cechoslovakischen Republik. (*Formerly Zeitschrift für die Zuckerindustrie in Böhmen.*)
447. India Rubber World.
448. Proceedings 4th International Congress of Refrigeration.
449. Caoutchouc et gutta percha.
450. Transactions of the Institution of the Rubber Industry.
451. Memoirs of the College of Engineering, Kyoto Imperial University. (*See No. 429.*)
452. Die oesterreichische pharmazeutische Post.
453. Proceedings of the Iowa Academy of Science.
454. Procès-verbaux et résumé des communications de la société française de physique.
455. Journal of the Chemical, Metallurgical and Mining Society of South Africa.
456. Gummi-Zeitung.
457. Chemist and Druggist.
458. Linnean Society of New South Wales, Proceedings.
459. Electrical Review and Industrial Engineer. (*Formerly Electrical Review and Western Electrician.*)
460. Deutsche Zuckerindustrie, Wochenblatt für Landwirtschaft, Fabrikation und Handel.
461. Proceedings of the Royal Society of New South Wales.
462. Bulletin institut international du froid.
463. Société de physique et d'histoire naturelle de Genève. Mémoires.
464. United States Public Health Service. Hygienic Laboratory Bulletins.
465. Zeitschrift der deutschen Öl- und Fett-Industrie.
466. Repertorium der analytischen Chemie (Organ des Vereins analytischer Chemiker). (*See also No. 92.*)

467. Zeitschrift für Chemie. Leipzig.
468. Kongliga Svenska Vetenskaps-Akademiens, Handlingar.
469. Bulletin of the Institute of Physical and Chemical Research (Tokyo).
470. Memoirs of the College of Engineering, Kyushu Imperial University.
471. Army Ordnance.
472. Papier-Fabrikant.
473. Cellulosechemie.
474. Zeitschrift für komprimierte und flüssige Gase sowie die Pressluft-Industrie.
475. Bulletin institut international du froid.
476. Giornale di farmacia, chimica e di scienze affini.
477. Journal of the American Medical Association.
478. Bulletin de l'association des chimistes de sucrerie et de distillerie de France et des colonies.
479. Memoirs of the College of Science and Engineering, Kyoto Imperial University. (*Divided in 1914 into Nos. 429 and 451.*)
480. Chemical Trade Journal and Chemical Engineer.
481. Tschermak's mineralogische und petrographische Mitteilungen.
482. Quarterly Journal of the Indian Chemical Society.
483. American Dyestuff Reporter (including the Proceedings of the American Association of Textile Chemists and Colorists).
484. Deutsches Archiv für klinische Medizin.
485. Teknisk Tidskrift. Upplaga C. Kemi och Bergsvetenskap.
486. Münchener medizinische Wochenschrift.
487. Die deutsche pharmazeutische Zeitung.
488. Archivio di farmacologia sperimentale e scienze affini.
489. Fermentforschung.
490. Atti e memorie della reale accademia di scienze, lettere ed arti in Padova.
491. Wochenblatt für Papierfabrikation.
492. Bulletin of the U. S. Dept. of Agriculture, Bureau of Soils.
493. Kali (Zeitschrift für Gewinnung, Verarbeitung und Verwertung der Kalisalze).
494. Beiträge zur chemischen Physiologie und Pathologie. Zeitschrift für die gesamte Biochemie. (*In 1908, merged with No. 205.*)
495. Vierteljahresschrift für praktische Pharmazie. (*Combined in 1923 with No. 293.*)
496. Mémoires de l'institut polytechnique, Pierre-le-Grand, Pétrograd.
497. Archiv for Pharmaci og Chemi.
498. Pharmazeutische Zeitschrift für Russland.
499. Archiv für Mineralogie, Geognosie, Bergbau und Hüttenkunde (Karstens).
500. Zeitschrift für das Berg-, Hütten- und Salinenwesen in dem preussischen Staate.
501. Mémoires couronnés et autres mémoires publiés par l'académie royale des sciences, des lettres et des beaux-arts de Belgique. Collection in 8vo.
502. Archives du Musée Teyler. (Harlem.)
503. Quarterly Journal of Science, Literature and the Arts.
504. Mémoires de l'académie des sciences de l'union des républiques soviétiques socialistes. (*Formerly Mémoires de l'académie impérial des sciences de St. Pétersbourg; name changed in 1917 to Mémoires de l'académie des sciences de Russie; present name dates from 1925.*)
505. Technology Reports of the Tôhoku Imperial University.
506. Monthly Weather Review.
507. Meteorologische Zeitschrift.
508. Rivista di mineralogia e cristallografia italiana.
509. Archiv für Chemie und Meteorologie. A section of Archiv für die gesamte Naturlehre (Kastners Archiv).
510. Zeitschrift für den physikalischen und chemischen Unterricht.
511. Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht. (Verein zur Förderung des Unterrichts in der Mathematik und den Naturwissenschaften.) (Hoffmanns Zeitschrift.)
512. Proceedings of the Indian Association for the Cultivation of Science.
513. Zeitschrift für Mathematik und Mechanik.
514. Maandblad voor Natuurwetenschappen. (Genootschap ter Bevordering van Natuur-Genees- en Heelkunde te Amsterdam.)
515. Magyar Chemikai Folyóirat (Budapest).
516. Zeitschrift für das gesamte Brauwesen. (*Now supplement to Allgemeiner Brauer- und Hopfenzeitung.*)
517. Perfumery and Essential Oil Record.
518. Landwirtschaftlichen Versuchs-Stationen.
519. Svensk Kemisk Tidskrift.
520. Monthly Notices of the Royal Astronomical Society. (London.)
521. Bulletins of the Lick Observatory. (Mt. Hamilton, Calif.)
522. Illuminating Engineer. (London.)
523. Gesammelte Abhandlungen zur Kenntnis der Kohle.
524. Abhandlungen der k. Akademie der Wissenschaften, Berlin. (K. preussische Akademie der Wissenschaften.)
525. Publications of the American Astronomical Society.
526. Bihang til Kongliga Svenska Vetenskaps-Akademiens Handlingar. (*In 1904, divided into Nos. 19 and 20.*)
527. Ertisítő az Erdélyi Múzeum Egylet Arvos-Természettudományi Szakosztályából. II. Természettudományi Szak.
528. Zeitschrift für wissenschaftliche Mikroskopie und für mikroskopische Technik.
529. Proceedings of the Institute of Radio Engineers (New York).
530. American Architect and the Architectural Review.
531. Internationale Zeitschrift für physikalisch-chemische Biologie.
532. Popular Astronomy.
533. Deutsche Bunsen-Gesellschaft für angewandte physikalische Chemie, Abhandlungen.
534. Proceedings of the National Electric Light Association.
535. Transactions of the International Electrical Congress.
536. Abhandlungen der k. Gesellschaft der Wissenschaften zu Göttingen. Mathematisch-physikalische Klasse.
537. Gesellschaft zur Beförderung der gesamten Naturwissenschaften (Marburg), Schriften.
538. Transactions of the International Astronomical Union.
539. Proceedings of the Royal Irish Academy. Section A, Mathematical, Astronomical and Physical Science. Section B, Biological, Geological and Chemical Science.
540. Radio Review. (*Now merged into Wireless World.*)
541. Transactions of the Society of Naval Architects and Marine Engineers.
542. Kongelige Danske Videnskabernes Selskab, Mathematisk-fysiske Meddelelser.
543. Proceedings of the Imperial Academy of Tokyo. (*Formerly Tokyo Academy.*)
544. Transactions of the Cambridge Philosophical Society.
545. Photographische Korrespondenz.
546. Bureau of Standards Journal of Research.
547. British Journal of Photography.
548. Sitzungsberichte der Gesellschaft zur Beförderung der gesamten Naturwissenschaften (Marburg).
549. Naturhistorisch-medizinischer Verein (Heidelberg). Verhandlungen.
550. Anales de la sociedad científica Argentina.
551. Monatsberichte der k. preussische Akademie der Wissenschaften (Berlin). (*Follows the "Berichte" and is followed by the "Sitzungsberichte."*)

552. Rensselaer Polytechnic Institute, Engineering and Science Series.
553. Cosmos. Revue encyclopédique hebdomadaire des progrès des sciences. *United with* Cosmos: Les mondes, revue hebdomadaire des sciences *to form* Cosmos: Revue des sciences et leurs applications.
554. Åbo Akademi. Acta academia aboensis, mathematica et physica.
555. Masarykova Universita (Brünn or Brno). Přírodovědecká fakulta, Spisy = Publications de la Faculté de science de l'Université Masaryk.
556. Handelingen van Lettiende Vlaamsch Naturen Geneeskundig Congress.
557. Transactions Royal Society, South Africa.
558. Acta phytochimica.
559. Stain Technology.
560. Color Trade Journal.
561. Bulletin de la société de chimie biologique.
562. Archives of Internal Medicine.
563. Zeitschrift Farben Textile Chemie.
564. Annales des Mines de Belgique.
565. Explosives in Coal Mines Orders.
566. Jahresbericht der Centralstelle für wissenschaftlich-technische Untersuchungen, Neubabelsberg-Berlin.
567. Annual Reports of His Majesty's Inspectors of Explosives.
568. Die Sprengstoffe in preussischen Bergbau.
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- B1. Hund, Linienspektren und periodisches System der Elemente. Berlin, Springer, 1927.
- B2. Glazebrook, R. T., Dictionary of Applied Physics. London, Macmillan, 1922-23.
- B3. Landolt-Börnstein, Physikalisch-chemische Tabellen. 5th ed. Berlin, Springer, 1923.
- B4. Singer, Die Keramik im Dienste von Industrie und Volkswirtschaft. Braunschweig, Vieweg, 1923.
- B5. Rieke and Gary, Die Prüfung von Porzellan, 1922. Reprinted from *104*, 3: 5; 22.
- B6. Gilchrist and Klinefelter, High Voltage Porcelain Insulators. Westinghouse Electric and Manufacturing Company, Special Pub. 1690, 1925.
- B7. Peek, Dielectric Phenomena in High Voltage Engineering. New York, McGraw-Hill Book Company, Inc., 1920.
- B8. Rziha and Seidener, Starkstromtechnik. Taschenbuch für Elektrotechniker. 5th ed. Berlin, Ernst, 1922.
- B9. Pender, Handbook of Electrical Engineering. 1922.
- B10. Doelter, Handbuch der Mineralchemie. Leipzig, Steinkopff, 1912-
- B11. Smithsonian Physical Tables. Government Printing Office, Washington, D. C.
- B12. Friese, Das Porzellan als Isolier- und Konstruktions-Material in der Elektrotechnik. Klosterlausnitz, 1904.
- B13. Nernst Festschrift, 1912. Knapp, Halle.
- B14. Haber, Thermodynamik technischer Gasreaktionen, 1905.
- B15. Vago, Dissertation, Budapest, 1911.
- B16. Horek, Dissertation, Berlin, 1909.
- B17. Isambert, Thesis, Toulouse, 1868.
- B18. Webb, Thesis, Princeton, 1924.
- B19. Felsing, Thesis, Massachusetts Institute of Technology, 1914.
- B20. Crut, Thesis, Paris, 1923.
- B21. Abegg, Handbuch der anorganischen Chemie.
- B22. Benoit, Thesis, Nancy, 1923.
- B23. Thomsen, J., Systematisk gennemførte termokemiske undersøgelsers numeriske og teoretiske resultater, 1882-1886.
- B24. Fuller, Tests of the Physical and Electrical Properties of Slate. Fritz Eng. Lab., Lehigh Univ., 1921.
- B25. Gilmore, Report on the Compressive Strength, Specific Gravity and Absorption of Various Kinds of Building Stones from Different Sections of the U. S. Government Printing Office, Washington, D. C., 1874.
- B26. Hirschwald, Handbuch der bautechnischen Gesteinsprüfung. Berlin, Borntraeger, 1912.
- B27. Hermann, Gesteine für Architektur und Sculptur. Berlin, Borntraeger, 1914.
- B28. Johnson, Comparison of Experiments on American and Foreign Building Stones. New Haven, Hamlen. Reprinted from *American Journal of Science and Arts*, 11: 1; 51.
- B29. Merrill, Stones for Building and Decoration. 3rd ed. New York, Wiley, 1903.
- B30. Popplewell and Carrington, Properties of Engineering Materials. London, Methuen, 1923.
- B31. Schweizerische Geotechnische Kommission, Die natürlichen Bausteine und Dachschiefer der Schweiz. Bern, 1915.
- B32. U. S. Ordnance Department, Tests of Metals and Other Materials. Washington, Government Printing Office, 1894.
- B33. U. S. Geological Survey, The Stone Industry in 1903. Washington, Government Printing Office, 1903.
- B34. Bygden, Thesis, Upsala, 1916.
- B35. de Pauw, Dissertation, Utrecht, 1922.
- B36. Hernquist, Dissertation, Upsala, 1914.
- B37. Kullaseff, Dissertation, Dorpat, 1915.
- B38. Lambrette, Dissertation, Brunies, 1923.
- B39. Rayman, Dissertation, Budapest.
- B40. Shorthose, D. N., Thermal Properties of Methyl Chloride. Food Investigation Board. Department of Scientific and Industrial Research (Great Britain). Special Report 19, 1924.
- B41. Vase, A. M., Liev, Dissertation, Kajane, 1917.
- B42. Breithaupt, J. F., Thesis, Univ. de Genève, 38 N° 446.
- B43. Bregmann, Dissertation, Lausanne, Kiew, 1914.
- B44. Bokhorst S. C., Dissertation, Amsterdam, 1915.
- B45. Jonescu, Dissertation, Genève, 1913.
- B46. Uretos, Spyro A., Thesis, Zürich, 1914.
- B47. Cocheret, Dissertation, Leiden, 1911, 15.
- B48. Hohn, These de Doctorat, Amsterdam, 1921.
- B49. Kelech, Thesis, Zürich, 1912.
- B50. Gmelin-Kraut's Handbuch der anorganischen Chemie. Heidelberg, Winter, 1906-
- B51. Seidell, Solubilities of Inorganic and Organic Substances. New York, Van Nostrand, 1919.
- B52. Strauli, Dissertation, Zürich, 1918.
- B53. Beiträge zur Kennt. d. Umwandl. polym. Körper, Göttingen, 1894.
- B54. Winter, Dissertation, Leipzig, 1913.
- B55. Eissner, Dissertation, Leipzig, 1913.
- B56. Onnes Festschrift, Leiden, 1922.
- B57. Tammann, Krystallisieren und Schmelzen. Leipzig, Barth, 1903.
- B58. Dissertation, Halle, 1890.
- B59. Thèse, École Pharm., Montpellier, 1895.
- B60. Fourth International Congress of Refrigeration Reports, Papers presented by the President. Leiden, Ijdo, 1924.
- B61. Ullmann, Encyclopädie der techn. Chemie. Wien, Urban and Schwarzenberg, 1914-23.
- B62. Henning, Die Grundlagen, Methoden und Ergebnisse der Temperaturmessung. Braunschweig, Vieweg, 1915.
- B63. Holborn, Scheel and Henning, Wärmetabellen. Braunschweig, Vieweg, 1919.
- B64. Ostwald and Luther, Hand- und Hilfsbuch zur Ausführung physikochemischer Messungen. 3rd ed. Leipzig, Akad. Verlagsges. m. b. H., 1922.
- B65. Stähler, Handbuch der Arbeitsmethoden in der anorganischen Chemie. 5 volumes. Berlin and Leipzig, de Gruyter & Co., 1920.

- B66. Zsigmondy, Kolloidchemie; ein Lehrbuch. 4th ed., Leipzig, Spamer, 1922.
- B67. Jenkin and Shorthose, Thermal Properties of Ethyl Chloride. Food Investigation Board, Department of Scientific and Industrial Research (Great Britain). Special Report No. 14, 1923.
- B68. Abraham, Asphalt and Allied Substances, Their Occurrence, Mode of Production, Uses in the Arts and Methods of Testing. New York, Van Nostrand, 1920.
- B69. Helmholtz, Physiological Optics, translated from the 3rd German edition by Southall. Optical Society of America, 1924.
- B70. Parson, An Introduction to the Study of Color Vision. Cambridge Univ. Press, 1915.
- B71. Mellor, Treatise on Inorganic and Theoretical Chemistry. London, Longmans, 1922-
- B72. Bunsen, Gasometrische Methoden. 2nd ed. Braunschweig, 1877.
- B73. Berthelot, Thermochemie. Paris, Gauthier-Villars, 1897.
- B74. Rieke, Das Porzellan. Hanover, 1910.
- B75. Société d'encouragement pour l'industrie nationale, Contribution à l'étude des argiles et de la céramique. Paris, Chapuy, 1906.
- B76. Winkelmann, Handbuch der Physik. Leipzig, Barth, 1903-09.
- B77. Marks, Mechanical Engineers' Handbook. 2nd ed. New York, McGraw-Hill Book Company, Inc., 1914.
- B78. Siegbahn, Spektroskopie der Röntgenstrahlen. Berlin, Springer, 1924. English ed., The Spectroscopy of X-Rays. London, Oxford Univ. Press, 1925.
- B79. de Vries, Estate Rubber. Batavia, Drukkerijen Ruycrok, 1920.
- B80. Mulder, Bijdragetol de geschiedenis van het scheikundig gebonden water. Rotterdam, 1864.
- B81. Great Britain Challenger Office: Report of Scientific Results. Voyage H. M. S. Challenger, Physics and Chemistry.
- B82. Lunge and Berl, Chemisch-technische Untersuchungsmethoden. Berlin, Springer, 1910.
- B83. Royds, Heat Transmission by Radiation, Conduction and Convection. London, Constable, 1921.
- B84. Griffiths and Davis, Food Investigation Board, Department of Scientific and Industrial Research (Great Britain). Special Report No. 9, 1922.
- B85. Société française de physique, Recueil de Constantes Physiques. Paris, Gauthier-Villars, 1913.
- B86. Exner and Haschek, Die Spektren der Elemente bei normalen Druck. Wien, Deuticke, 1912.
- B87. Guerther, Metallographie. Berlin, Borntraeger, 1909-
- B88. Marx, Handbuch der Radiologie. Akademische Verlagsgesellschaft m. b. H., Leipzig, 1925.
- B89. Richardson, Emission of Electricity from Hot Bodies. New York, Longmans, 1921.
- B90. Graetz, Handbuch der Elektrizität und Magnetismus. Leipzig, Barth, 1912-28.
- B91. Sosman, The Properties of Silica. New York, Chemical Catalog Co., Inc., 1927.
- B92. Paschen and Götze, Seriengesetze der Linienpektren. Berlin, Springer, 1922.
- B93. Fowler, Report on Series in Line Spectra. London, Fleetway Press, 1922.
- B94. Sommerfeld, Atombau und Spektrallinien. Braunschweig, Vieweg, 1924.
- B95. Geiger and Scheel, Handbuch der Physik. Berlin, Springer, 1926-
- B96. Kayser, Handbuch der Spektroskopie, 1900- (1924?). Leipzig, Hirzel.
- B97. Nietzsche, Theory of Development. New York, Van Nostrand, 1922.
- B98. Sonderabdruck aus der Festschrift zur Feier des siebenzigsten Geburtstages Richard Dedekind. Braunschweig, Vieweg, 1901.
- B99. van't Hoff, Vorlesungen über theoretische und physikalische Chemie. Braunschweig, Vieweg, 1898.
- B100. Lewkowitsch, Chemical Technology and Analysis of Oils, Fats and Waxes. 6th ed. London, Macmillan, 1921-23.
- B101. de Broglie, Les Rayons-X. Paris, Blanchard, 1922.

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